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VOL. XII NO. 2

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

NYASALAND SOILS

In a previous number of this Bulletin (1912, **10**, 55), an account was given of the results of examination at the Imperial Institute of a series of soils from the chief cotton-growing areas in the Nyasaland Protectorate.

Since then two further series of Nyasaland soils have been examined, viz. thirty-one from the Lake Shirwa district, and four typical soils from tobacco estates in the Protectorate.

The soils from the Lake Shirwa district were collected by Mr. E. B. Gamlen, First Assistant Agriculturist of the Nyasaland Department of Agriculture, during a tour in this area which comprised the following itinerary: Leaving Zomba on August 15, 1912, Mr. Gamlen proceeded along the Mlanje road as far as the Namadzi stream, and then down the Palombe stream to Lake Shirwa. From thence, passing Pyupyu Hill on his right, he crossed the Naisi and Songani streams, reaching the Domasi stream near Chikala Hill, and returned from there via Msondole and the Liwonde road to Zomba. Mr. Gamlen's notes on the soils in this area are as follows:

Between Zomba and the Namiwawa stream the soil is a light clay loam; beyond this to the Ntondwe stream

it is a very fertile, deep, sandy loam. Beyond the Ntondwe to the Namadzi the soil is thin and stony, and not much cultivated. Going down the Palombe stream one finds a heavy clay soil extending almost to Lake Shirwa, where it changes in character to alluvium or gravel. Thence going in a north-westerly direction to the Likangala stream there is a hard clay with patches of sand overlying it in places. The area near Lake Shirwa is not much cultivated, as the drainage is defective owing to the presence of "hard pan" beneath the surface; but the soil immediately by the lake shore is very fertile. If this "pan" could be broken it is thought that excellent crops might be grown. North of the Likangala to Pyupyu Hill the soil is a fertile, sandy loam, that near the hill being a red clay identical with that found at Zomba, with rocks close to the surface. North of Pyupyu Hill to the Domasi stream the soil is chiefly light sand, but clay occurs near the Naisi, Songani, and Domasi streams. Returning to Zomba, deep sandy soil prevails till Msondole is reached; from thence to the Liwonde-Zomba road a clay loam occurs, and in the valley between this road and the Domasi Mission a heavy clay. Patches of very fertile soil occur near the various streams crossed on the homeward road to Zomba, and are well cultivated by the natives.

The samples collected in the Lake Shirwa District were examined with a view to ascertaining their suitability for the cultivation of cotton and tobacco. Each sample, which represented the soil and subsoil to a depth of 12 in., was submitted to (1) a mechanical analysis, performed on the entire soil, which was air-dried before examination, and (2) a chemical analysis of that portion of the soil which passed through a 1 mm. sieve. The figures giving the "available" constituents in pounds per acre were calculated in each case for a depth of 9 in., the apparent specific gravity of the soil being taken into account. The four typical tobacco soils were examined on similar lines. The descriptions applied to samples Nos. 1 to 31 are those given on the labels attached to the samples, but they do not in all cases strictly agree with the results of the mechanical analyses.

Soils from the Lake Shirwa District

No. 1.—"Sandy loam, Zomba-Mlanje road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·20	43·06	14·03	35·95	2·17	0·06 [1]

[1] *Including chlorides equivalent to* 0·004 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·38	—	—
Magnesia	MgO	—	0·43	—	—
Potash	K_2O	—	0·19	0·018	525
Ferric oxide	Fe_2O_3	—	6·16	—	—
Phosphoric acid	P_2O_5	—	0·11	0·004	117
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		8·43	—	—	—
Humus		0·79 [2]	—	—	—

[1] *Equivalent to* 2,450 *lb. per acre.* [2] *Containing nitrogen* 10·63 *per cent.*

This soil contains sufficient "acid-soluble" lime, potash, and phosphoric acid. There is also an adequate quantity of "available" potash, but the percentage of "available" phosphoric acid is low. The quantity of nitrogen present is below the standard required for many crops, but would probably suffice for cotton or "bright" tobacco. For cotton cultivation it would be advisable to increase the quantity of humus in the soil by "green manuring."

No. 2.—"Deep clay loam, Ulumba Hill."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·84	34·71	25·33	29·17	4·26	0·05[1]

[1] *Including chlorides equivalent to* 0·001 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·024 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·16	—	—
Magnesia	MgO	—	0·88	—	—
Potash	K_2O	—	0·28	0·018	488
Ferric oxide	Fe_2O_3	—	9·04	—	—
Phosphoric acid	P_2O_5	—	0·72	0·162	4,395
Nitrogen	N	0·15[1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		13·14	—	—	—
Humus		2·27[2]	—	—	—

[1] *Equivalent to* 4,069 *lb. per acre.* [2] *Containing nitrogen* 3·65 *per cent.*

This soil contains a sufficiency of all the constituents necessary for crops, and is noteworthy for its high percentage of phosphoric acid. The large amount of phosphoric acid and the richness in nitrogen would make this soil rather unsuitable for the cultivation of "bright" tobacco until the quantities of these constituents have been somewhat reduced by growing other crops, but otherwise the soil appears to be well suited either for "bright" tobacco or cotton.

No. 3.—"Sandy loam (clay subsoil), Government Farm, River Namiwawa."

Mechanical Analysis

Sizes of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
5·24	38·38	20·80	33·14	2·37	0·07 [1]

[1] *Including sulphates equivalent to* 0·038 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·20	—	—
Magnesia	MgO	—	0·45	—	—
Potash	K_2O	—	0·08	0·021	589
Ferric oxide	Fe_2O_3	—	6·96	—	—
Phosphoric acid	P_2O_5	—	0·15	0·003	84
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		9·31	—	—	—
Humus		0·59 [2]	—	—	—

[1] *Equivalent to* 1,907 *lb. per acre.* [2] *Containing nitrogen* 7·83 *per cent.*

This soil contains adequate supplies of "acid-soluble" lime and phosphoric acid, and of "available" potash. The percentages of nitrogen, and especially that of "available" phosphoric acid, are however low, and the amount of "acid-soluble" potash is also rather low.

For the cultivation of cotton or "bright" tobacco the proportion of "available" phosphoric acid in this soil needs to be augmented; this could be done by applying basic slag or bone meal, or a dressing of lime would serve the same purpose for a time. For the cultivation of cotton or tobacco, but especially of the former, the soil would benefit by "green manuring," as this would increase the amounts of humus and nitrogen present.

No. 4.—"Sandy loam, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·14	61·06	16·87	15·06	1·40	0·08[1]

[1] *Including sulphates equivalent to* 0·046 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·27	—	—
Magnesia	MgO	—	0·34	—	—
Potash	K_2O	—	0·22	0·012	402
Ferric oxide	Fe_2O_3	—	6·40	—	—
Phosphoric acid	P_2O_5	—	0·16	0·020	670
Nitrogen	N	0·06[1]	—	—	—
Carbon dioxide	CO_2	0·03	—	—	—
Loss on ignition		5·86	—	—	—
Humus		0·85[2]	—	—	—

[1] *Equivalent to* 2,179 *lb. per acre.* [2] *Containing nitrogen* 7·66 *per cent.*

This soil contains sufficient quantities of the mineral plant foods, but the percentage of nitrogen is low. The soil appears to be suitable for the cultivation of "bright" tobacco, but it would require "green manuring" to render it fit for growing cotton.

No. 5.—"Deep loam, Kaserema's Village, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·36	36·88	24·73	29·57	3·90	0·07[1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·015 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·36	—	—
Magnesia	MgO	—	0·34	—	—
Potash	K_2O	—	0·10	0·018	497
Ferric oxide	Fe_2O_3	—	2·80	—	—
Phosphoric acid	P_2O_5	—	0·11	0·039	1,077
Nitrogen	N	0·11 [1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		11·15	—	—	—
Humus		1·22 [2]	—	—	—

[1] *Equivalent to* 3,039 *lb. per acre.* [2] *Containing nitrogen* 6·55 *per cent.*

This soil contains a sufficient supply of all the necessary plant-food ingredients, except that the reserve of potash, as shown by the quantity soluble in hydrochloric acid, is somewhat low. The soil is suitable for the cultivation of cotton or "bright" tobacco.

No. 6.—"Loam (stony subsoil), Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14·18	56·09	16·92	10·92	2·35	0·07 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·005 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·17	—	—
Magnesia	MgO	—	0·77	—	—
Potash	K_2O	—	0·25	0·008	227
Ferric oxide	Fe_2O_3	—	5·61	—	—
Phosphoric acid	P_2O_5	—	0·31	0·109	3,100
Nitrogen	N	0·05 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		6·00	—	—	—
Humus		0·82 [2]	—	—	—

[1] *Equivalent to* 1,422 *lb. per acre.* [2] *Containing nitrogen* 4·87 *per cent.*

This soil contains adequate supplies of all the plant-food constituents except nitrogen. It is noteworthy for its high percentages of "acid-soluble" and "available" phosphoric acid.

From the description of the subsoil it appears probable that this soil, which is of a sandy character as a whole, would not be sufficiently retentive of moisture for the cultivation of cotton or "bright" tobacco. If these crops are tried it will be advisable to "green manure" the soil for cotton, and to apply potash, preferably in the form of wood, or plant ashes rich in this constituent, for tobacco.

No. 7.—"Deep loam, Namadzi Stream, Zomba-Mlanje Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·26	49·08	37·27	11·64	2·45	0·06 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·016 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·52	—	—
Magnesia	MgO	—	0·82	—	—
Potash	K_2O	—	0·15	0·005	138
Ferric oxide	Fe_2O_3	—	4·52	—	—
Phosphoric acid	P_2O_5	—	0·12	0·072	1,989
Nitrogen	N	0·10 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		7·60	—	—	—
Humus		1·52 [2]	—	—	—

[1] *Equivalent to* 2,763 *lb. per acre.* [2] *Containing nitrogen* 3·29 *per cent.*

This soil contains a sufficient supply of plant-food constituents, but for the culture of "bright" tobacco it

would need to be supplied with potash. The soil might be tried for cotton cultivation, and it is probable that the crop would be successful if the subsoil is fairly retentive of moisture.

No. 8.—"Deep sandy loam, River Palombe, Sanji Hill."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1·57	48·51	35·46	11·55	2·30	0·08 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·012 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·37	—	—
Magnesia	MgO	—	0·58	—	—
Potash	K_2O	—	0·14	0·018	512
Ferric oxide	Fe_2O_3	—	4·68	—	—
Phosphoric acid	P_2O_5	—	0·07	0·013	369
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		16·65	—	—	—
Humus		1·55 [2]	—	—	—

[1] *Equivalent to* 2,275 *lb. per acre.* [2] *Containing nitrogen* 2·59 *per cent.*

This soil contains sufficient "acid-soluble" lime, and "available" potash and phosphoric acid. The proportions of nitrogen and of "acid-soluble" potash and phosphoric acid are, however, rather below standard. The soil is suitable for growing "bright" tobacco, provided that potash is applied in a short time, and it might be used for cotton cultivation if it is underlain by a retentive subsoil.

No. 9.—"Peaty soil, plain near River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7·16	34·45	16·17	38·85	3·56	0·16[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·035 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·53	—	—
Magnesia	MgO	—	0·36	—	—
Potash	K_2O	—	0·11	0·007	185
Ferric oxide	Fe_2O_3	—	7·29	—	—
Phosphoric acid	P_2O_5	—	0·10	0·007	185
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	0·07	—	—	—
Loss on ignition		11·15	—	—	—
Humus		2·74[2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 2·3 *per cent.*

This soil contains sufficient quantities of "acid-soluble" lime and phosphoric acid, and of "available" potash. The amounts of nitrogen, "acid-soluble" potash, and "available" phosphoric acid are, however, rather below standard. If the soil was treated with potash it would probably be suitable for the cultivation of "bright" tobacco, but for cotton growing it would benefit by the application of a phosphatic manure.

No. 10.—"Sand, near Dianyama's Village, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17·28	58·45	11·20	12·23	1·20	0·06[1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·53	—	—
Magnesia	MgO	—	0·40	—	—
Potash	K_2O	—	0·17	0·016	471
Ferric oxide	Fe_2O_3	—	5·27	—	—
Phosphoric acid	P_2O_5	—	0·11	0·014	412
Nitrogen	N	0·05[1]	—	—	—
Carbon dioxide	CO_2	0·04	—	—	—
Loss on ignition		5·60	—	—	—
Humus		0·71[2]	—	—	—

[1] *Equivalent to* 1,473 *lb. per acre.* [2] *Containing nitrogen* 6·3 *per cent.*

This soil contains sufficient supplies of mineral plant-food constituents, but the proportion of nitrogen is low. The soil appears to be suitable for the cultivation of cotton or "bright" tobacco, provided that the subsoil is sufficiently retentive of moisture. For cotton growing it would need "green manuring."

No. 11.—"Deep loam (clay subsoil), River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7·00	42·43	14·41	32·68	3·41	0·13[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·028 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·35	—	—
Magnesia	MgO	—	0·41	—	—
Potash	K_2O	—	0·08	0·016	409
Ferric oxide	Fe_2O_3	—	7·70	—	—
Phosphoric acid	P_2O_5	—	0·07	0·008	205
Nitrogen	N	0·07[1]	—	—	—
Carbon dioxide	CO_2	0·04	—	—	—
Loss on ignition		10·69	—	—	—
Humus		0·98[2]	—	—	—

[1] *Equivalent to* 1,792 *lb. per acre.* [2] *Containing nitrogen* 6·1 *per cent.*

This soil contains adequate supplies of "acid-soluble" lime and "available" potash, but the quantities of the other plant-food constituents are below standard. For the growing of "bright" tobacco it would probably suffice if potash were applied to the soil, but for cotton cultivation it would be necessary to apply a phosphatic manure, and to adopt a course of "green manuring."

No. 12.—"Clay, Chitungas, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture. at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·38	37·30	21·25	36·83	4·81	0·11 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·022 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·82	—	—
Magnesia	MgO	—	0·94	—	—
Potash	K_2O	—	0·26	0·016	390
Ferric oxide	Fe_2O_3	—	9·36	—	—
Phosphoric acid	P_2O_5	—	0·46	0·041	999
Nitrogen	N	0·13 [1]	—	—	—
Carbon dioxide	CO_2	0·06	—	—	—
Loss on ignition		15·49	—	—	—
Humus		2·58 [2]	—	—	—

[1] *Equivalent to* 3,170 *lb. per acre.* [2] *Containing nitrogen* 3·1 *per cent.*

This soil contains adequate amounts of all the necessary plant-food constituents, and appears to be suitable for cotton cultivation. For the growing of "bright" tobacco it is rather "heavy," and would need the application of potash in order to increase the "available" supply of this constituent.

No. 13.—"Clay, near Chimombo's Village, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1·51	13·52	44·30	35·50	5·33	0·12[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·023 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO . .	—	0·64	—	—
Magnesia	MgO . .	—	0·70	—	—
Potash	K_2O . .	—	0·18	0·013	343
Ferric oxide	Fe_2O_3 . .	—	4·56	—	—
Phosphoric acid	P_2O_5 . .	—	0·39	0·075	1,981
Nitrogen	N . .	0·09[1]	—	—	—
Carbon dioxide	CO_2 . .	0·06	—	—	—
Loss on ignition	. . .	13·45	—	—	—
Humus		2·05[2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 3·2 *per cent.*

This soil contains adequate quantities of mineral plant-food constituents, but the percentage of nitrogen is slightly below standard. The soil is suitable for cotton cultivation, but it is rather "heavy" for "bright" tobacco, and if the latter crop were tried it would be advisable to apply potash.

No. 14.—"Alluvial, near Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
12·40	34·49	23·02	26·56	3·80	0·16[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·031 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·40	—	—
Magnesia	MgO	—	1·11	—	—
Potash	K_2O	—	0·14	0·018	508
Ferric oxide	Fe_2O_3	—	4·88	—	—
Phosphoric acid	P_2O_5	—	0·17	0·029	819
Nitrogen	N	0·07[1]	—	—	—
Carbon dioxide	CO_2	0·06	—	—	—
Loss on ignition		8·97	—	—	—
Humus		1·01[2]	—	—	—

[1] *Equivalent to* 1,977 *lb. per acre.* [2] *Containing nitrogen* 5·1 *per cent.*

The soil contains adequate amounts of plant-food constituents except in the case of nitrogen. It appears to be suitable for the cultivation of either "bright" tobacco or cotton, but for the latter crop "green manuring" would probably be advisable. The soil, however, may prove unsuitable for either of these crops, as the area near Lake Shirwa is badly drained on account of underlying "hard pan" (see p. 180).

No. 15.—"Sand, Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
34·61	63·41	1·08	0·87	0·17	0·08[1]

[1] *Including chlorides equivalent to* 0·001 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·009 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·13	—	—
Magnesia	MgO	—	0·08	—	—
Potash	K_2O	—	0·01	0·006	190
Ferric oxide	Fe_2O_3	—	0·85	—	—
Phosphoric acid	P_2O_5	—	0·04	0·019	602
Nitrogen	N	0·03[1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		1·42	—	—	—
Humus		0·30[2]	—	—	—

[1] *Equivalent to* 951 *lb. per acre.* [2] *Containing nitrogen* 4·3 *per cent.*

This soil is deficient in "acid-soluble" lime, phosphoric acid, and potash, and also in nitrogen. The "available" phosphoric acid is sufficient, but the "available" potash is rather low. The soil is too poor and sandy for the satisfactory cultivation of tobacco or cotton, and, as in the case of the preceding soil, it may also suffer from "hard pan" in the subsoil.

No. 16.—"Alluvial soil by Lake Shirwa, River Palombe."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·35	6·40	84·84	8·35	0·06[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·00	—	—
Magnesia	MgO	—	1·25	—	—
Potash	K_2O	—	0·39	0·021	529
Ferric oxide	Fe_2O_3	—	9·12	—	—
Phosphoric acid	P_2O_5	—	0·34	0·073	1,839
Nitrogen	N	0·24[1]	—	—	—
Carbon dioxide	CO_2	0·08	—	—	—
Loss on ignition		23·24	—	—	—
Humus		2·60[2]	—	—	—

[1] *Equivalent to* 6,046 *lb. per acre.* [2] *Containing nitrogen* 5·65 *per cent.*

This soil contains a good supply of all the necessary plant-food constituents, but it is too clayey for the successful cultivation of cotton or "bright" tobacco.

No. 17.—"Deep clay soil, Makawa Village, Likangala River."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	8·85	13·80	69·09	8·17	0·09 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO	—	0·55	—	—
Magnesia MgO	—	0·61	—	—
Potash K_2O	—	0·23	0·024	610
Ferric oxide Fe_2O_3	—	7·20	—	—
Phosphoric acid P_2O_5	—	0·21	0·047	1,194
Nitrogen N	0·20 [1]	—	—	—
Carbon dioxide CO_2	0·02	—	—	—
Loss on ignition	22·14	—	—	—
Humus	2·38 [2]	—	—	—

[1] *Equivalent to* 5,080 *lb. per acre.* [2] *Containing nitrogen* 4·94 *per cent.*

This soil contains a good supply of the necessary plant-food constituents, but is probably of too "heavy" a character for the cultivation of cotton or "bright" tobacco.

No. 18.—"Sand (clay subsoil), Makawa Village, Likangala River."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	57·35	16·90	23·16	2·56	0·03 [1]

[1] *Including chlorides equivalent to* 0·002 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·31	—	—
Magnesia	MgO	—	0·44	—	—
Potash	K_2O	—	0·15	0·011	304
Ferric oxide	Fe_2O_3	—	3·92	—	—
Phosphoric acid	P_2O_5	—	0·14	0·040	1,105
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		7·42	—	—	—
Humus		1·21[2]	—	—	—

[1] *Equivalent to* 2,487 *lb. per acre.* [2] *Containing nitrogen* 4·45 *per cent.*

This soil contains adequate quantities of the necessary mineral plant-food constituents, but the amount of nitrogen is slightly below standard. The soil appears to be suitable for the cultivation of "bright" tobacco if manured with potash, and it would also be suitable for cotton cultivation if the drainage is satisfactory.

No. 19.—"Sandy loam, Mbalu Village, near Pyupyu Mountain."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	47·00	33·70	16·80	2·19	0·01[1]

[1] *Including a trace of sulphuric acid, but no chlorine.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·42	—	—
Magnesia	MgO	—	0·36	—	—
Potash	K_2O	—	0·13	0·012	317
Ferric oxide	Fe_2O_3	—	4·16	—	—
Phosphoric acid	P_2O_5	—	0·18	0·100	2,462
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		6·87	—	—	—
Humus		1·31[2]	—	—	—

[1] *Equivalent to* 2,377 *lb. per acre.* [2] *Containing nitrogen* 4·27 *per cent.*

This soil closely resembles the preceding sample, No. 18, and the same remarks and recommendations apply to both samples.

No. 20.—"Sandy loam (sandy subsoil), Hasambwe Village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	73·05	11·25	14·05	1·20	0·05 [1]

[1] *Including sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

	Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
	Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime CaO . .	—	0·16	—	—
Magnesia MgO . .	—	0·22	—	—
Potash K_2O . .	—	0·11	0·007	213
Ferric oxide Fe_2O_3 . .	—	2·35	—	—
Phosphoric acid P_2O_5 . .	—	0·13	0·036	1,097
Nitrogen N . . .	0·05 [1]	—	—	—
Carbon dioxide CO_2 . .	0·02	—	—	—
Loss on ignition . . .	5·20	—	—	—
Humus	0·70 [2]	—	—	—

[1] *Equivalent to* 1,569 *lb. per acre.* [2] *Containing nitrogen* 5·4 *per cent.*

This soil contains adequate quantities of "acid-soluble" and "available" potash and phosphoric acid, but is deficient in nitrogen, and rather low in lime. For cotton cultivation the soil is rather sandy, and in view of the sandy nature of the subsoil it may perhaps not be sufficiently retentive of moisture to satisfy the requirements of the cotton plants, although in other respects it appears quite suitable for this crop. The culture of "bright" tobacco would necessitate the application of potash, and the subsoil would probably be unsuitable for this crop.

No. 21.—"Light clay loam, Palawe Village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14·80	44·80	28·64	10·04	1·30	0·06[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·24	—	—
Magnesia	MgO	—	0·15	—	—
Potash	K_2O	—	0·18	0·018	512
Ferric oxide	Fe_2O_3	—	6·00	—	—
Phosphoric acid	P_2O_5	—	0·12	0·033	944
Nitrogen	N	0·057[1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		6·00	—	—	—
Humus		0·45[2]	—	—	—

[1] *Equivalent to* 1,621 *lb. per acre.* [2] *Containing nitrogen* 8·4 *per cent.*

This soil contains adequate supplies of most of the plant-food ingredients, but is rather low in lime, and deficient in nitrogen. It would probably be suitable for either cotton or "bright" tobacco, provided that the subsoil is sufficiently retentive of moisture.

No. 22.—"Sandy loam (clay subsoil), Palawe village, Mount Pyupyu."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
7·60	56·24	20·00	14·60	1·58	0·11[1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·27	—	—
Magnesia	MgO	—	0·31	—	—
Potash	K_2O	—	0·19	0·011	313
Ferric oxide	Fe_2O_3	—	4·27	—	—
Phosphoric acid	P_2O_5	—	0·03	0·009	256
Nitrogen	N	0·098[1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		5·38	—	—	—
Humus		1·52[2]	—	—	—

[1] *Equivalent to* 2,792 *lb. per acre.* [2] *Containing nitrogen* 4·6 *per cent.*

This soil is deficient in "acid-soluble" and "available" phosphoric acid. For "bright" tobacco culture it would benefit by the application of potash, and for cotton cultivation "green manuring" would be advisable in order to increase the quantity of organic matter in the soil.

No. 23.—"Clay, River Naisi, Kanda's Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·80	41·48	25·12	26·68	2·84	0·10[1]

[1] *Including a minute trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·47	—	—
Magnesia	MgO	—	0·53	—	—
Potash	K_2O	—	0·20	0·015	396
Ferric oxide	Fe_2O_3	—	3·53	—	—
Phosphoric acid	P_2O_5	—	0·32	0·093	2,457
Nitrogen	N	0·128[1]	—	—	—
Carbon dioxide	CO_2	0·01	—	—	—
Loss on ignition		9·42	—	—	—
Humus		3·2[2]	—	—	—

[1] *Equivalent to* 3,381 *lb. per acre.* [2] *Containing nitrogen* 2·1 *per cent.*

This soil contains adequate quantities of plant-food constituents. It would be suitable for the cultivation of "bright" tobacco or cotton, but for the former crop it would be advisable to apply potash.

No. 24.—"Sand, Ndala Stream, between Rivers Naisi and Songani."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
9·50	78·75	10·45	0·95	0·37	0·01 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·004 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·12	—	—
Magnesia	MgO	—	0·38	—	—
Potash	K_2O	—	0·03	0·009	310
Ferric oxide	Fe_2O_3	—	1·60	—	—
Phosphoric acid	P_2O_5	—	0·10	0·031	1,069
Nitrogen	N	0·03 [1]	—	—	—
Carbon dioxide	CO_2	0·08	—	—	—
Loss on ignition		1·66	—	—	—
Humus		0·23 [2]	—	—	—

[1] *Equivalent to* 1,035 *lb. per acre.* [2] *Containing nitrogen* 8·69 *per cent.*

The quantities of "acid-soluble" potash, lime, and total nitrogen in this soil are low, but the "available" potash and phosphoric acid are satisfactory. The soil appears to be too sandy for the cultivation of tobacco or cotton.

No. 25.—"Loam (clay subsoil), River Songani, Banongwe Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·63	33·45	30·33	31·73	3·50	0·05 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (*Cl*) *and sulphates equivalent to* 0·014 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·36	—	—
Magnesia	MgO	—	0·51	—	—
Potash	K_2O	—	0·24	0·012	317
Ferric oxide	Fe_2O_3	—	5·96	—	—
Phosphoric acid	P_2O_5	—	0·11	0·047	1,241
Nitrogen	N	0·11 [1]	—	—	—
Carbon dioxide	CO_2	0·04	—	—	—
Loss on ignition		10·88	—	—	—
Humus		2·07 [2]	—	—	—

[1] *Equivalent to* 2,905 *lb. per acre.* [2] *Containing nitrogen* 3·38 *per cent.*

This soil contains adequate quantities of plant-food ingredients. It appears to be suitable for cotton growing, but would probably require the addition of potash for the successful cultivation of "bright" tobacco.

No. 26.—"Clay loam (sandy subsoil), River Domasi, Nkombe Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13·25	41·21	22·90	20·11	1·94	0·04 [1]

[1] *Including sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·19	—	—
Magnesia	MgO	—	0·35	—	—
Potash	K_2O	—	0·16	0·013	388
Ferric oxide	Fe_2O_3	—	3·60	—	—
Phosphoric acid	P_2O_5	—	0·21	0·073	2,180
Nitrogen	N	0·09 [1]	—	—	—
Carbon dioxide	CO_2	0·07	—	—	—
Loss on ignition		6·79	—	—	—
Humus		1·31 [2]	—	—	—

[1] *Equivalent to* 2,688 *lb. per acre.* [2] *Containing nitrogen* 3·89 *per cent.*

The soil contains satisfactory amounts of plant-food constituents, except perhaps in the case of the nitrogen and lime, which are slightly low. In view of the sandy subsoil it is possible that the land will not prove very suitable for the cultivation of cotton or "bright" tobacco, but much will depend on the depth of the top-soil.

No. 27.—"Light sandy loam near River Domasi."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
14·50	67·12	9·92	6·80	1·13	0·02 [1]

[1] *Including sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received. No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·04	—	—
Magnesia	MgO	—	0·11	—	—
Potash	K_2O	—	0·04	0·005	178
Ferric oxide	Fe_2O_3	—	2·32	—	—
Phosphoric acid	P_2O_5	—	0·02	0·017	608
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	0·10	—	—	—
Loss on ignition		4·74	—	—	—
Humus		1·08 [2]	—	—	—

[1] *Equivalent to* 2,861 *lb. per acre.* [2] *Containing nitrogen* 4·63 *per cent.*

This soil contains sufficient "available" potash, and a satisfactory amount of "available" phosphoric acid, but it shows a deficiency in "acid-soluble" potash, phosphoric acid, and lime. The amount of total nitrogen is slightly low. The soil is rather sandy, but it would probably be suitable for either "bright" tobacco or cotton if the subsoil is sufficiently retentive of moisture.

No. 28.—"Deep sandy loam, River Songani, near Msondole Village."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·55	55·75	22·03	18·56	2·68	0·05 [1]

[1] *Including a trace of chlorine, and sulphates equivalent to* 0·02 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·42	—	—
Magnesia	MgO	—	0·64	—	—
Potash	K_2O	—	0·32	0·032	806
Ferric oxide	Fe_2O_3	—	5·44	—	—
Phosphoric acid	P_2O_5	—	0·19	0·061	1,537
Nitrogen	N	0·13 [1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		8·08	—	—	—
Humus		1·37 [2]	—	—	—

[1] *Equivalent to* 3,276 *lb. per acre.* [2] *Containing nitrogen* 4·00 *per cent.*

This soil contains adequate quantities of plant-food ingredients, and would probably be suitable for cotton or "bright" tobacco provided that the subsoil is sufficiently retentive of moisture.

No. 29.—"Clay loam, near Msondole, Zomba-Liwonde Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
16·84	54·60	15·01	11·32	1·59	0·05 [1]

[1] *Including sulphates equal to* 0·02 *per cent. sulphuric acid* (SO_3). *No chlorine was present.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·34	—	—
Magnesia	MgO	—	0·30	—	—
Potash	K_2O	—	0·06	0·013	409
Ferric oxide	Fe_2O_3	—	3·20	—	—
Phosphoric acid	P_2O_5	—	0·11	0·037	1,165
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·08	—	—	—
Loss on ignition		4·90	—	—	—
Humus		1·25 [2]	—	—	—

[1] *Equivalent to* 2,204 *lb. per acre.* [2] *Containing nitrogen* 3·44 *per cent.*

The "acid-soluble" potash in this soil is low, and the "acid-soluble" phosphoric acid is rather low, as is also the nitrogen. The soil is rather sandy, but it would probably be suitable for growing either cotton or "bright" tobacco if the subsoil is sufficiently retentive of moisture.

No. 30.—"Stiff clay, valley near Domasi Mission.'

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
6·56	49·20	17·87	24·66	1·62	0·14 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·034 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·15	—	—
Magnesia	MgO	—	0·40	—	—
Potash	K_2O	—	0·08	0·010	285
Ferric oxide	Fe_2O_3	—	4·91	—	—
Phosphoric acid	P_2O_5	—	0·09	0·003	85
Nitrogen	N	0·05 [1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		7·56	—	—	—
Humus		0·67 [2]	—	—	—

[1] *Equivalent to* 1,422 *lb. per acre.* [2] *Containing nitrogen* 5·9 *per cent.*

The amounts of "acid-soluble" potash, "available" and "acid-soluble" phosphoric acid, and nitrogen in this soil are low; the lime is also rather low. The soil could be used for cotton growing if the humus and nitrogen were augmented by "green manuring," and a dressing of some phosphatic manure were applied. For growing "bright" tobacco the soil would also need the application of potash.

No. 31.—"Deep loam (sandy subsoil), Naisi Stream, Zomba-Liwonde Road."

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·77	62·34	17·72	14·03	1·36	0·16 [1]

[1] *Including chlorides equivalent to* 0·009 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·050 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	--	0·19	—	—
Magnesia	MgO	—	0·52	—	—
Potash	K_2O	—	0·14	0·013	343
Ferric oxide	Fe_2O_3	—	5·01	—	—
Phosphoric acid	P_2O_5	—	0·24	0·034	898
Nitrogen	N	0·10 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		7·06	—	—	—
Humus		1·27 [2]	—	—	—

[1] *Equivalent to* 2,642 *lb. per acre.* [2] *Containing nitrogen* 4·1 *per cent.*

This sample contains sufficient supplies of plant-food constituents. The soil is however rather sandy, and in view of the sandy character of the subsoil it may not perhaps be sufficiently retentive of moisture to satisfy the requirements of cotton and "bright" tobacco, although in other respects it appears quite suitable for these crops.

Soils from Tobacco Estates

No. 32.—Chiranga Estate, Nyasaland. A brown loamy soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
4·47	42·04	22·70	28·82	2·45	0·09 [1]

[1] *Including chlorides equivalent to* 0·010 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·015 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, i.e. portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·40	—	—
Magnesia	MgO	—	0·22	—	—
Potash	K_2O	—	0·14	0·030	852
Ferric oxide	Fe_2O_3	—	6·88	—	—
Phosphoric acid	P_2O_5	—	0·14	0·025	710
Nitrogen	N	0·15 [1]	—	—	—
Carbon dioxide	CO_2	0·02	—	—	—
Loss on ignition		10·75	—	—	—
Humus		1·72 [2]	—	—	—

[1] *Equivalent to* 4,260 *lb. per acre.* [2] *Containing nitrogen* 5·23 *per cent.*

This soil contains adequate quantities of the necessary plant-food constituents, but the reserve of potash is rather low and precautions should be taken to conserve it as much as possible.

No. 33.—Ntondwe Estate, Nyasaland. A brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11·64	38·74	16·48	30·71	2·37	0·06 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (*Cl*), *and sulphates equivalent to* 0·01 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·10	—	—
Magnesia	MgO	—	0·13	—	—
Potash	K_2O	—	0·15	0·011	320
Ferric oxide	Fe_2O_3	—	6·60	—	—
Phosphoric acid	P_2O_5	—	0·04	0·021	610
Nitrogen	N	0·10[1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		9·46	—	—	—
Humus		0·86[2]	—	—	—

[1] *Equivalent to* 2,906 *lb. per acre.* [2] *Containing nitrogen* 5·93 *per cent.*

This soil is somewhat deficient in reserves of lime and "acid-soluble" phosphoric acid, and manures containing these constituents should be supplied shortly. In cultivation every precaution should be taken to conserve the potash, and if the tobacco grown on this soil shows any defect in burning quality, the soil should be manured with wood ashes or some similar product rich in potash.

No. 34.—Naisi Estate, Nyasaland. A brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·06	46·72	19·20	29·63	2·37	0·02[1]

[1] *Including traces of chlorides and sulphates.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	0·29	—	—
Magnesia	MgO	—	0·48	—	—
Potash	K_2O	—	0·34	0·016	475
Ferric oxide	Fe_2O_3	—	6·68	—	—
Phosphoric acid	P_2O_5	—	0·10	0·016	475
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	0·05	—	—	—
Loss on ignition		8·80	—	—	—
Humus		0·96[2]	—	—	—

[1] *Equivalent to* 2,670 *lb. per acre.* [2] *Containing nitrogen* 5·00 *per cent.*

. This soil contains a sufficiency of plant food constituents, but for crops other than tobacco it would benefit by "green manuring."

No. 35.—Mlungusi Estate, Nyasaland. A dark brown loam.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
11·85	36·02	28·95	19·52	3·81	0·16

[1] *Including a trace of chlorides, and sulphates equivalent to* 0·021 *per cent. sulphuric acid* (SO_3), *expressed on the sample as received.*

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO . .	—	0·77	—	—
Magnesia	MgO . .	—	0·67	—	—
Potash	K_2O . .	—	0·20	0·021	504
Ferric oxide	Fe_2O_3 . .	—	6·95	—	—
Phosphoric acid	P_2O_5 . .	—	0·43	0·055	1,319
Nitrogen	N . . .	0·32 [1]	—	—	—
Carbon dioxide	CO_2 . .	0·06	—	—	—
Loss on ignition	. . .	16·03	—	—	—
Humus	. . . . .	4·71 [2]	—	—	—

[1] *Equivalent to* 7,674 *lb. per acre.* [2] *Containing nitrogen* 3·47 *per cent.*

This soil contains a sufficiency of plant-food constituents. The percentage of nitrogen is however very high for a satisfactory soil for "bright" tobacco, and it would probably improve the soil for this crop if one or two crops of maize or other similar product were taken off it.

General Remarks

In making suggestions as to the suitability of the various soils for cotton and "bright" tobacco it has been assumed that the climatic and other conditions are suitable for these crops. Further, in making these sug-

gestions, comparisons have been made with the results of analyses of cotton soils from Nyasaland previously examined at the Imperial Institute, and with the four tobacco soils on which reports are now furnished (*Nos.* 32 to 35), rather than with the soils on which cotton and "bright" tobacco are grown in the United States and elsewhere.

PENGUIN GUANO FROM THE FALKLAND ISLANDS

THE five samples of penguin guano from the Falkland Islands which are the subject of this report were received in October 1913.

It was stated that the samples had been obtained from Cochon and Kidney Islands, and it was desired to ascertain their commercial value and the best method of preparing the guano for export.

The samples were as follows:

Nos. 1, 2, *and* 3. *From Cochon Island.*—These consisted of black, wet, slimy masses, containing much organic matter together with some fibrous material. A few small bones of birds and a small quantity of sand were also present.

Nos. 4 *and* 5. *From Kidney Island.*—These were similar to those from Cochon Island, but No. 4 contained, in addition to the constituents mentioned above, about 7 per cent. of fine gravel.

The samples were submitted to preliminary examination at the Imperial Institute with the following results:

	From Cochon Island.			From Kidney Island.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture, on drying at 105° C.	72·93	75·62	74·06	63·69	80·07
Additional loss on ignition .	15·69	15·24	13·71	21·73	12·13
Ash	11·38	9·14	12·23	14·58	7·80

Chemical analyses of the samples as received at the Imperial Institute showed them to contain the following proportions of manurial and other constituents:

	From Cochon Island.			From Kidney Island.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lime CaO	3·74	2·92	1·26	1·52	2·46
Magnesia MgO	0·72	0·17	0·10	0·33	0·41
Potash K_2O	0·19	0·16	0·32	0·21	0·20
Soda Na_2O	0·35	0·32	0·31	0·26	0·32
Sulphuric acid SO_3	0·09	0·14	0·10	0·21	0·08
Chlorine Cl	0·20	0·38	0·36	0·17	0·27
Phosphoric acid P_2O_5	4·22	3·48	1·22	1·55	2·66
Consisting of:					
Portion soluble in 2 per cent. citric acid solution[1]	4·08[1]	3·28[1]	1·11[1]	1·24[1]	2·32[1]
Portion insoluble in 2 per cent. citric acid solution	0·14	0·20	0·11	0·31	0·34
Nitrogen N	1·71	1·23	0·96	1·23	1·02
Consisting of:					
Portion present in organic form	1·17	0·78	0·61	1·00	0·70
,, ,, as ammonium salts	0·49	0·25	0·27	0·03	0·21
Portion present as nitrates	0·05	0·20	0·08	0·20	0·11
[1] Including phosphoric acid (P_2O_5) soluble in water	1·02	0·30	0·50	0·80	0·63

The commercial value of these samples in the United Kingdom, based on the average current values per unit per cent. for the constituents nitrogen, phosphoric acid, and potash, would be approximately as follows (March 1914):

Sample.	Value per ton c.i.f. United Kingdom ports.
No. 1	32*s.*
No. 2	24*s.*
No. 3	17*s.*
No. 4	21*s.*
No. 5	20*s.*

It is evident that, at the prices quoted above, it would not be remunerative to export guanos of the composition of the present samples to any considerable distance. The results of the analyses show, however, that the samples contained an excessive quantity of water, varying from 64 to 80 per cent.; and if this could be reduced to say 20 per cent. these materials from Cochon and Kidney Islands would be comparable with certain commercial guanos.

The following table shows the results of re-calculating the amounts of the valuable constituents of these guanos,

assuming the amount of moisture present to have been reduced to 20 per cent. Analyses recorded by Fritsch for another sample from the Falkland Islands, and for three samples of Peruvian guano are added for comparison:

	Moisture. H_2O.	Nitrogen. N.	Potash. K_2O.	Phosphoric acid. P_2O_5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Cochon Island, No. 1 . . .	20·0	5·05	0·56	12·45
,, ,, ,, 2 . . .	20·0	4·03	0·53	11·42
,, ,, ,, 3 . . .	20·0	3·17	0·98	3·72
Kidney Island, No. 4 . . .	20·0	2·71	0·46	3·41
,, ,, ,, 5 . . .	20·0	4·08	0·80	10·64
Sample from the Falkland Islands, as recorded by Fritsch . .	8·86	1·24	—	9·75
Samples from Peru:				
Lobos de Afuera Island . .	19·60	3·60	2·50	16·70
Guanape Island. . . .	25·88	11·00	2·50	12·25
Ballestas Island. . . .	14·87	12·50	2·50	12·23

It will be seen from these figures that as compared with good Peruvian guano the present samples from the Falkland Islands contained much less nitrogen and potash, and the percentage of phosphoric acid is also much lower in the case of samples 3 and 4. Samples 1, 2, and 5 are better as regards nitrogen and phosphoric acid than the guano from the Falkland Islands previously examined (No. 6 in table).

It is possible that the present samples are from the top layers of the deposits and may have been exposed to rain; in that case the guano situated at a short distance below the surface will probably prove to be richer in manurial constituents than these samples.

The Peruvian guanos of commerce, being obtained from a very dry region, are not specially dried before export, but if it is desired to prepare material similar to the present samples from the Falkland Islands for export the percentage of water should be reduced, in order to minimise freight charges and to render the guano easier to handle. On exposure to the air for six days it was found that sample No. 5 lost 70 per cent. of moisture, thus showing that under suitable conditions simple air-drying would suffice for the purpose.

FLAX FROM THE EAST AFRICA PROTECTORATE

THE cultivation of the flax plant for the production of seed has been conducted on an experimental scale for some years past in various parts of the East Africa Protectorate, and it is thought that there is every prospect of its cultivation becoming in a short time thoroughly established throughout a large portion of the Nyanza Province.

The cultivation of the plant for the production of fibre should be possible in the Highland districts of the Protectorate. A sample of flax fibre which had been prepared from the stems of plants grown for seed in the Limoru district was examined at the Imperial Institute some years ago (see this BULLETIN, 1911, **9**, 11), as well as fibre prepared from plants grown at the Government Experimental Farm, Kabete (*loc. cit.*, p. 13). Both these specimens had apparently been imperfectly retted, and their value was consequently low. Four further samples of fibre produced at Kabete were received for examination recently. They were as follows:

No. 1.—This sample, which was received in October 1913, consisted of flax which had been retted, broken, and scutched. It was of rather dark brownish-grey colour, soft and lustrous, and well cleaned and prepared, being practically free from "shieve." It was of good strength, and varied in length from 2 ft. 10 in. to 3 ft. 3 in., but was mostly about 3 ft.

It was examined with the following results compared with standard samples of Russian and Belgian flax:

	Present sample.	Standard Russian flax.	Standard Belgian flax.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	7·9	8·4	8·7
Ash	1·0	0·9	0·9
α-Hydrolysis, loss . .	14·4	12·7	11·0
β-Hydrolysis, loss . .	22·0	21·1	19·2
Acid purification, loss .	4·7	5·2	3·9
Cellulose	82·5	83·4	84·5

The length of the ultimate fibres ranged from 0·5 to 2·9 in., with an average of 1·6 in., and their diameter varied from 0·0004 to 0·001 in., with an average of 0·0007 in.

The fibre was regarded by experts as worth £50 per ton (December 1913).

The above results indicate that this flax was of good quality, and that it closely resembled the standard European varieties in chemical composition and behaviour. The experts to whom the fibre was submitted for valuation stated that it should be of great interest to the spinning trade of the United Kingdom, which imports from Russia and other parts of Europe about 90,000 tons of flax annually.

The following three samples were received in January of this year. In each case the flax had been retted, broken, and scutched.

No. 2.—"Fibre obtained from straw not laid by rain." This sample consisted of lustrous, fairly soft fibre, well cleaned and prepared, and almost free from "shieve." The colour was slightly irregular, varying from a light brownish-grey to a somewhat darker brownish- or greenish-grey. The strength of the fibre was rather irregular, but on the whole was good. Its length varied from about 2 ft. to 3 ft. 4 in., but was mostly about 2 ft. 9 in.

No. 3.—"Fibre obtained from straw not badly laid by rain." This sample was soft and lustrous, fairly well cleaned and prepared, and contained only a small quantity of "shieve." It was darker than No. 2, the colour being dark brownish- or greenish-grey. The fibre was of irregular strength, the greater part being good, whilst that of some portions was poor. It varied in length from about 2 ft. to 3 ft. 4 in., but was mostly about 2 ft. 8 in.

No. 4.—"Fibre obtained from straw badly laid by rain." This sample was slightly harsh, moderately lustrous, and fairly well cleaned and prepared, containing only a very small proportion of "shieve." The colour was dark brownish- or greenish-grey, similar to that of sample No. 3. The strength of the fibre was irregular and on the whole rather poor. The length ranged from about 18 in. to 2 ft. 11 in., but was mostly about 2 ft. 2 in. A good deal of short towy fibre was also present.

Samples 2, 3, and 4 were examined with the following results, compared with those afforded by a standard sample of Belgian flax;

	No. 2.	No. 3.	No. 4.	Standard Belgian flax.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	9·3	9·3	8·0	8·7
Ash	1·1	1·0	1·2	0·9
α-Hydrolysis, loss . .	9·4	11·4	10·7	11·0
β-Hydrolysis, loss . .	18·3	18·7	18·9	19·2
Acid purification, loss .	2·2	3·0	2·8	3·9
Cellulose . . .	85·0	82·5	83·6	84·5
Length of ultimate fibres	from about 0·2 in. to 3·4 in.	from about 0·2 in. to 2·7 in.	from about 0·2 in. to 3·3 in.	—
Diameter of ultimate fibres . . .	0·0003 in. to 0·0010 in.; average 0·00057 in.	0·0003 in. to 0·0009 in.; average 0·00060 in.	0·0004 in. to 0·0014 in.; average 0·00066 in.	—

Sample No. 2 was of very satisfactory quality, although somewhat dark in colour; it was valued at £56 per ton. No. 3 was of good quality and was valued at £48 to £50 per ton, but its value was reduced by its dark colour and uneven strength. No. 4 was valued at £40 per ton, its value being reduced by its weak and rather towy nature and by its dark colour.

In chemical composition and behaviour, these three samples of flax (Nos. 2, 3, and 4) closely resembled a standard specimen of Belgian flax with which they were compared, and the ultimate fibres were of about the usual length and diameter for flax fibre.

The fibre merchants in London who valued the samples reported very favourably on them, particularly No. 2, which they stated would be saleable in any quantity in the United Kingdom. They described Nos. 3 and 4 as flaxes of good medium quality, for which they could readily find a good market at about the prices quoted in the present report. They regarded all the samples as superior to Russian flaxes and more comparable with the Belgian kinds.

COCOA FROM THE SOUTHERN PROVINCES, NIGERIA

Cocoa is grown on a considerable scale in the Southern Provinces, Nigeria, and large quantities have been exported in recent years, as is shown in the following table;

	1910.	1911.	1912.
Quantity, lb. . .	6,567,181	9,858,774	7,593,711
Value, £ . . .	101,151	164,664	130,542

Attempts have been made by the Department of Agriculture to improve the quality of the cocoa produced, and as already mentioned in this BULLETIN (1913, 11, 144), the Department recently undertook the preparation of a certain quantity of native-grown cocoa for the market. Experiments have been in progress on the fermentation and drying of cocoa beans, and two series of samples produced in the course of these experiments have been received at the Imperial Institute for examination.

SERIES I

The five samples of cocoa which are the subject of this report were received in January 1914.

No. 1.—"Fermented, and artificially dried for fifteen hours in rotary drier."

This sample consisted of fairly large unwashed beans of uniform size, plump and in good condition. In many cases the husk was cracked or broken away from the kernel. The fracture was frequently slatey. The flavour of the beans was mild and fairly pleasant.

No. 2.—"Fermented, dried in the sun for two hours, and then artificially dried for fourteen hours in rotary drier."

Unwashed beans of uniform size, plump, clean, and in good condition. The husk was brittle, but usually unbroken, and showed a white powdery bloom. The fracture in some cases was pale brown, but often of a purplish tint. The flavour was mild and fairly pleasant.

No. 3.—"Fermented, sun-dried for three hours, and then artificially dried in the rotary drier for nine hours."

These beans closely resembled those of sample No. 2, with the exception that beans with a slatey fracture were much less frequent.

No. 4.—"Fermented and sun-dried."

These beans were unwashed, of uniform size, fairly large, clean, and in good condition. The husk was unbroken. The fracture was similar to that of No. 3.

No. 5.—"Sample prepared on native farm; for comparison."

Unwashed beans of medium to fairly large size, but of rather dirty appearance. Some of the beans were plump, but the majority were somewhat shrivelled. The fracture was usually slatey.

The size, weight, etc., of the beans as received at the Imperial Institute were as follows:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Relative size, i.e. number of beans required to fill a 200 c.c. cylinder 5·3 cm. in diameter . . .	76	81	75	71	95
Average weight of a single bean, in grams	1·33	1·30	1·34	1·47	1·11
Percentage of husk in beans . .	11·7	11·5	11·3	10·9	13·7

The beans, after removal of the husks, were analysed with the following results:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . . .	4·7	4·5	4·3	4·2	4·6
Ash	2·5	2·5	2·5	2·5	2·6
Fat	49·9	46·5	46·8	49·5	47·3
Total alkaloids . .	1·77	1·58	1·80	1·62	1·63

In chemical composition the five samples of beans were of normal character, and showed no material difference.

The samples were too small to be submitted to manufacturers for trial, but they were sent for valuation to a firm of brokers, who reported that in their opinion the five products were all very good. They valued them as follows in Liverpool (March 1914):

Sample.	Price per cwt.
No. 1	57*s.*
No. 2	54*s.* 6*d.* to 55*s.* 6*d.*
No. 3	61*s.*
No. 4	60*s.*
No. 5	56*s.*

On the date of these valuations, "African" cocoa was quoted in Liverpool at 51*s.* 6*d.*–55*s.* 3*d.* per cwt., and in London as follows:

		Per cwt.
S. Thomé and Cameroons	Grey to colory . .	59*s.* to 62*s.*
East Coast . . .	Good red. . . .	64*s.* to 75*s.*
British West Coast . .	Fair to good . . .	48*s.* to 56*s.*

It is satisfactory that of these five cocoas from Nigeria, Nos. 3 and 4 were valued at rates very similar to those obtainable for S. Thomé cocoa, and that the other three were valued at prices equal to those obtainable for the best grades of British West African cocoa that now come on the market. Nos. 1 and 2, which were valued at lower rates than Nos. 3 and 4, in spite of their having been fermented, seem to have suffered somewhat from over-drying, as is shown in the brittleness and broken condition of the husks, and the curious cheese-like appearance shown by some of the fractured beans in these two samples was probably due to the same cause.

Series II

Two samples of cocoa which had been prepared by heating the beans at a suitable temperature in a rotary drier without previous fermentation were received in January 1914.

No. 6.—This sample consisted of unwashed, clean, plump, fairly large beans, having a brown husk, which was brittle and in most cases broken. The beans broke easily, the fracture being of a purple colour. The flavour was somewhat harsh and bitter.

No. 7.—Clean, plump, fairly large beans, having a pale brown husk with dark brown patches. The beans broke fairly easily, the fracture being of a curious slatey purplish-brown colour. The flavour was rather harsh.

The size, weight, etc., of the beans as received at the Imperial Institute were as follows:

	No. 6.	No. 7.
Relative size, i.e. number of beans required to fill a 200 c.c. cylinder, 5·3 cm. in diameter.	77	75
Average weight of a single bean, in grams	1·28	1·32
Percentage of husk in beans	9·7	11·7

The beans, after removal of the husks, were analysed with the following results, indicating a normal composition:

	No. 6. *Per cent.*	No. 7. *Per cent.*
Moisture	4·0	3·5
Ash	3·2	3·5
Fat	48·7	48·6
Total alkaloids	1·92	1·87

The samples were submitted to a firm of brokers in Liverpool, who reported that they were of good quality, No. 6 being worth 54*s.* 6*d.* to 55*s.* 6*d.* per cwt., and No. 7 54*s.* to 55*s.* per cwt.

These samples, although unfermented, were valued at comparatively good prices, as will be seen by comparing the prices of African cocoa on the same date, quoted on p. 215.

It is clear, however, that treatment of cocoa beans in a rotary drier, without previous fermentation, will not yield a product as valuable as the fermented and dried cocoas represented by samples 3 and 4 dealt with in the preceding report, which were valued at 61*s.* and 60*s.* per cwt. respectively.

COPALS FROM BRITISH WEST AFRICA

THE chief sources of copal are East Africa, West Africa, the Dutch East Indies, certain islands in Polynesia, New Zealand, New Caledonia, and the north-eastern parts of South America. The East African product, known in commerce as Zanzibar animi or copal, is a fossil kind found chiefly in localities from which copal trees have now disappeared. The copal of New Zealand and New Caledonia is better known in trade as Kauri copal, and is also a fossil product derived originally from the Kauri pine, *Dammara australis*. The Dutch East Indian and Polynesian copals are entirely obtained from living trees, and chiefly from *D. orientalis*, while that from South America ("Demerara animi") is collected mainly from living trees of *Hymenæa Courbaril*, but is also found in the fossil form. The West African material is obtained throughout the coastal region from Sierra Leone to the Portuguese Congo territory, and is of very variable quality, the best sorts being fossil or semi-fossil and the medium and poorest qualities being procured from living trees. The exports of copal from British territories in West Africa in recent years are shown in the following table:

	1910.		1911.		1912.	
	cwts.	£	*cwts.*	£	*cwts.*	£
Sierra Leone . . .	644	3,331	555	2,966	340	1,607
Southern Nigeria . .	269	459	205	363	1,454	1,686
Gold Coast . . .	481	647	715	1,110	599	1,077

Copal from each of the above countries has already been dealt with in this BULLETIN (1907, **5**, 16; 1908, **6**, 245); further samples from Nigeria and the Gold Coast have been examined recently, and an account of these is given below.

NIGERIA

Three samples of copal, described as "ozia" gum and derived from *Daniella Ogea*, Rolfe (= *Cyanothyrsus Ogea*, Harms), were received from Benin, Southern Provinces, in June 1909. No information regarding the method of preparation of these copals was supplied, other than the statement that they represented 1st, 2nd, and 3rd grades. They were as follows:

No. 1 *Grade.*—This sample consisted of (1) a cake of resin, weighing ½ lb., of pale yellow colour and free from foreign matter; and (2) small irregularly-shaped fragments, varying in colour from almost white to pale brown. The surfaces of the fragments were dull and covered with a thin coating of dust. The resin showed a conchoidal fracture. It was hard, and possessed a slight, pleasant odour.

No. 2 *Grade.*—Small irregular-shaped fragments of resin, of fairly uniform pale brown colour. The surfaces were dull and often covered with a thin "weathering" crust. Some pieces were clear, others partially opaque. The resin was hard, and possessed a faint, pleasant odour.

No. 3 *Grade.*—Fragments of fairly hard resin, varying in colour from pale yellow to dark brown, and covered with a thin "weathering" crust. Considerable quantities of dirt, pieces of bark, etc., were present. The resin had a faint, pleasant odour, especially when rubbed.

The samples were examined with the following results:

	No. 1.	No. 2.	No. 3.
Moisture . . . *per cent.*	0·25	1·85	0·93
Ash . . . . *per cent.*	0·25	0·25	0·21
Melting point[1]	100° C. (approx.)	115° C.	110° C.
Acid number[2]	110	123	119
Solubility in—			
Alcohol	Insoluble	Partly soluble	Partly soluble
Ether	Largely soluble	Partly soluble	Partly soluble
Benzene	Partly soluble	Slightly soluble	Insoluble
Alcohol and benzene . .	Nearly completely soluble	Nearly completely soluble	Nearly completely soluble
Turpentine oil . . .	Insoluble	Partly soluble	Partly soluble
,, ,, and benzene .	Swells up	Partly soluble	Insoluble
Alcohol and turpentine oil .	Partly soluble	Nearly completely soluble	Insoluble

[1] *Determined on the powdered copal in a capillary tube.*

[2] *Milligrams of potassium hydroxide required to neutralize one gram of copal.*

Samples Nos. 1 and 2 were "melted" to render them soluble in turpentine oil, and they lost 29 and 19·5 per cent. in weight, respectively, in the process. The resulting "melts" were dissolved in turpentine oil, yielding in each case a clear varnish of high brilliance, that produced from sample No. 1 having very little colour, whilst the other was pale yellow. It was found impossible to prepare a varnish in the same way from sample No. 3, as on melting it gave a very dark-coloured product which frothed up.

The samples were submitted for valuation to brokers and to a firm of varnish manufacturers. The latter reported that all the copals were rather below standard in regard to their melting points, and that they could not be strongly recommended for varnish-making purposes. The brokers' report was as follows (March 1910):

Sample.	Description.	Value. *Per cwt.*
No. 1.	Good quality, Accra kind . .	45*s.* to 47*s.* 6*d.*
No. 2.	Medium quality, Accra kind . .	35*s.*
No. 3.	Low quality, Accra kind . .	25*s.*

General Conclusions

This kind of copal is at best an inferior product as compared with the best kinds of fossil copal, such as those produced in East Africa, and known in commerce as Zanzibar copal, and that collected in New Zealand

and known as Kauri copal. Very fine copals of these types may fetch up to £500 per ton.

Apart from the matter of intrinsic quality, all crude copals can be improved by cleaning and "picking." The former operation is usually only necessary in the case of crude copals coated with a layer of "weathered" products. The object is to produce a bright clean surface, and for this purpose the crude copal is broken into pieces about 1 in. to 1½ in. cube, or smaller if convenient, all pieces of bark, etc., being removed, and placed for 24 hours in a tub with a dilute solution of caustic soda. A solution of about ½ per cent. strength should be enough in the case of copals such as these from Nigeria. The copal should be stirred up gently from time to time with a wooden stick, and after the treatment it should be washed several times in fresh water, any loosely adhering flocculent matter being brushed away, and any remaining fragments of bark, leaves, etc., scraped off with a blunt knife. It should then be spread out in a convenient place to dry. It is then ready for "picking," which consists in separating the crude copal by hand-picking, according to colour; the palest-coloured pieces are the best, and fetch the highest prices, and the dark-brown or almost black and opaque pieces are of least value. Each grade should consist of pieces of uniform colour and nearly uniform in size. The dust and chips should be kept separate and sold as lower grades.

Of the samples submitted in the present instance, the first grade merely requires breaking into uniform pieces and "picking," whilst Nos. 2 and 3 require to be cleaned to free them from bark, etc., then washed in alkali as described above, and finally "picked" according to colour. Treated in this fashion, the palest, clearest resin would probably fetch about 75*s.* per cwt. (March 1910), and the poorest grades would probably bring little if anything less than the price now quoted for the 3rd grade sample.

Gold Coast

Two samples of copal collected in the Dunkwa district of the Gold Coast were received in November 1913. The

ordinary Accra copal is derived from *Daniella similis*, Craib, but no information was supplied as to the origin of the present samples.

No. 1.—This consisted of a single piece of hard, transparent, pale yellow resin, clean and smooth externally, and free from foreign matter.

No. 2.—This was an irregular mass of hard, transparent, pale golden-brown resin, clean, but rough externally, and containing traces of foreign matter within.

The samples were analysed with the following results, compared with corresponding figures for copal from the Gold Coast previously examined at the Imperial Institute.

	Present samples.		Previous samples.
	No. 1.	No. 2.	
Moisture . . *per cent.*	0·8	2·8	—
Ash . . *per cent.*	0·03	0·06	0·1 to 2·2
Melting point . . .	115° C.	115° C.	120° C. to 180° C.
Acid number . . .	101·8	129·1	124 to 134
Saponification number .	107·3	135·8	—

The copals were "melted" to render them soluble in turpentine oil, losing 14·7 and 14·6 per cent. in weight respectively in the process. The resulting "melts" were dissolved in twice their weight of turpentine oil, yielding in each case a varnish which dried hard, pale, and lustrous.

The solubility of the samples was tested, with the following results, which were identical in the two cases:

Solvent.	Solubility of samples (No. 1 and No. 2).
Alcohol	Partly soluble.
Ether	Do. do.
Alcohol and ether . . .	Completely soluble.
Chloroform	Partly soluble.
Benzene	Do. do.
„ and alcohol	Completely soluble.
Turpentine oil	Partly soluble.
„ „ and alcohol . .	Completely soluble.
„ „ and benzene . .	Partly soluble.

These results are generally similar to those obtained for the solubility of samples of copal from the Gold Coast previously examined at the Imperial Institute.

The copals were submitted to a firm of brokers in Liverpool, who stated that if the material could be marketed in pale-coloured, clean, large pieces like the present samples, it would realise a very high price in the United Kingdom, possibly as much as 90*s.* to 100*s.* per cwt. (March 1914). If, however, it is only possible to offer the product in the condition of the ordinary Gold Coast copal now shipped to Liverpool, *i.e.* containing small fragments, dust, and dirt, it would have a similar value to the latter material, viz. 47*s.* to 51*s.* per cwt. for fairly clean parcels in good condition, or smaller prices, down to as little as 35*s.* per cwt. for inferior qualities (March 1914).

Copal of the kind represented by the present samples would be readily saleable in the United Kingdom, but, as indicated above, the prices obtainable would depend on the quality and the grading of the material.

ESSENTIAL OILS FROM VARIOUS COUNTRIES

Lemon Grass Oil from India

Five samples of commercial Cochin lemon grass oil were forwarded to the Imperial Institute by the Director of Agriculture at Madras in February 1913. They were sent as the result of statements that the Cochin lemon grass oil marketed in the United Kingdom had recently begun to show signs of "insolubility" (cf. Parry, *Perfumery and Essential Oil Record*, 1913, **4**, 40, and Umney, *loc. cit.* p. 119). In this connection it may be explained that hitherto two kinds of lemon grass oil have been recognised in commerce, viz. that typified by Cochin oil, which is "soluble" in 2 or more volumes of 70 per cent. alcohol, and that represented typically by West Indian oil, which is "insoluble" in 70 per cent. alcohol (cf. this Bulletin, 1911, **9**, 334).

The samples were examined in order to determine their solubility in 70 and 80 per cent. alcohol, and the results obtained are given in the following table:

Number of sample.	Description.	Solubility in 70 per cent. alcohol.	Solubility in 80 per cent. alcohol.
1	Kayan Kalam lemon grass oil.	Soluble to a clear solution in 2 vols.	—
2	Alwaye lemon grass oil . .	Soluble to a clear solution in $1\frac{3}{4}$ vols.	—
3	Alwaye lemon grass oil . .	Not soluble to a clear solution in 5 vols.	Soluble in $\frac{3}{8}$ vol., becoming cloudy on the addition of 2 vols.
4	Cochin lemon grass oil . .	Ditto.	Soluble in $\frac{3}{8}$ vol., becoming cloudy on the addition of 4 vols.
5	Alwaye lemon grass oil . .	Ditto.	Ditto.

Samples Nos. 4 and 5 were too small for detailed examination, but the first three oils in the above list were further examined with the following results:

	No. 1.	No. 2.	No. 3.
Specific gravity at $\frac{15°\,C.}{15°\,C.}$	0·901	0·917	0·908
Optical rotation α_D	$-5°\ 35'$ (at 21° C.)	not determined.	about $-2°$ (at 19° C.)
Aldehydes (by bisulphite method) *per cent.*	68·5	77	73

These results show that three of the five oils (Nos. 3, 4, and 5) would be classed as "insoluble," and support the statement that the proportion of "insoluble" oil from Cochin has increased recently.

As it was considered that this change in the character of the lemon grass oil shipped from Cochin might be due either to the employment of a variety of lemon grass different from that formerly used, or to a change in the method of distillation, further specimens of oil, obtained from the different kinds of grass used, were requested for examination.

Two samples of oil were accordingly submitted in August 1913, one distilled from "white stemmed" and the other from the "red stemmed" grass. The Director of Agriculture stated that both varieties grow wild, but that it is reported that in North and Central Travancore the red stemmed variety is cultivated to some extent. He mentioned that the oil is extracted from the wild and cultivated grasses indiscriminately.

"*White stemmed.*"—This was a cloudy yellow oil, with an odour more nearly resembling that of a citronella oil than that of a lemon grass oil. It gave the following results on examination:

	Oil from "white stemmed" grass.	Ceylon citronella oil, for comparison.
Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$	0·909	0·900 to 0·920
Optical rotation α_D	− 10° 50′ (at 22° C.)	− 7° to − 22°
Absorbed by sodium bisulphite *per cent.*	9	7 to 10
Solubility:		
In 80 per cent. alcohol	Soluble in 0·8 or more vols., becoming slightly turbid with 4 vols.	Dissolves to a clear solution with 1 to 2 vols.; with 10 vols. remains clear or shows only slight opalescence.
In 70 per cent. alcohol	Not soluble in 5 vols.	—

On shaking the oil with 5 vols. of 70 per cent. alcohol and allowing the mixture to stand, a clear separation of oil took place on top of the solvent.

This oil resembled a citronella oil rather than a true lemon grass oil, and it was therefore requested that herbarium specimens of the grass should be forwarded for determination. These have not yet been received.

"*Red stemmed.*"—This was a clear reddish-brown oil, possessing the usual odour of lemon grass oil. It gave the following results on examination:

	Oil from "red stemmed" grass.	East Indian lemon grass oil, for comparison.
Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$	0·925	0·899 to 0·905
Optical rotation α_D	The oil was too dark for this observation.	+ 1° 25′ to − 5°
Absorbed by sodium bisulphite *per cent.*	71·5	70 to 85
Solubility:		
In 80 per cent. alcohol	Soluble in 0·8 or more vols., becoming slightly turbid with 5 vols.	—
In 70 per cent. alcohol	Did not dissolve to a clear solution in 5 vols.	Soluble in 1·5 to 3 vols.

On shaking the oil with 5 vols. of 70 per cent. alcohol and allowing the mixture to stand, a few globules of oil separated at the bottom of the solvent.

In order to ascertain the cause of the insolubility of the "red stemmed" lemon grass oil in 70 per cent. alcohol, as compared with ordinary East Indian lemon grass oil, the following experiments were carried out:

(1) The oil was steam-distilled, until a distillate equivalent to 65 per cent. of the original oil was obtained. This distillate was of a bright yellow colour, whilst the residue of 35 per cent. was a reddish-brown viscous oil. The distillate and residue exhibited the following solubilities:

	Distilled oil.	Residual oil.
In 70 per cent. alcohol .	Soluble in 2·4 vols., and remaining clear on dilution	Insoluble in 12 vols.
In 80 per cent. alcohol .	—	Soluble in 0·9 vol., becoming turbid with 4 vols.

(2) The oil was steam-distilled until oil ceased to distil over. The distillate then amounted to 78·7 per cent. of the original oil. It was of a bright yellow colour, whilst the residual oil was dark reddish-brown, viscous, and slightly heavier than water.

The distillate contained 81 per cent. of aldehydes, as determined by sodium bisulphite absorption, and was soluble in 2·4 vols. of 70 per cent. alcohol, the solution remaining clear on further addition of alcohol.

These experiments indicate that the more volatile portions of the "red stemmed" lemon grass oil satisfy the test for solubility in 70 per cent. alcohol, whereas the less volatile portions do not. The insolubility of the entire oil is therefore apparently caused by the inclusion of these less volatile fractions of oil, the presence of which is probably due to the distillation having been carried too far.

Vetiver Oil from Fiji

The sample of vetiver oil which is the subject of this report was received at the Imperial Institute in April 1913. It consisted of a viscous, yellowish-brown oil, having the characteristic odour of vetiver. On exposure to air and light for a short time the colour became dark green.

The oil was examined with the following results, compared with the corresponding figures for a previous sample

from Fiji which was examined at the Imperial Institute (this BULLETIN, 1912, **10**, 32):

	Present sample.	Previous sample.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$ . .	1·018	1·0298
Solubility in 80 per cent. alcohol	Soluble in 1⅓ vol., becoming turbid with 3 or more vols.	Soluble in 2·5 vols., becoming turbid with more.
Saponification number . .	47	35·3

The optical rotation could not be determined, owing to the dark colour of the oil.

For comparison with these results the following analyses of other vetiver oils may be quoted:

	Vetiver oil purchased by the Imperial Institute in London.		German distilled vetiver oil (recorded by Gildemeister and Hoffmann).
Origin.	Java.	Réunion.	—
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	1·044	1·001	1·015 to 1·030
Solubility in 80 per cent. alcohol . . .	Soluble in 1 vol. or more.	Soluble in 1 vol. or more.	Soluble in 1·5 to 2 vols.; becoming turbid with more.
Saponification number .	56·0	10·6	60 to 80

It will be seen that the present sample of Fiji vetiver oil differs considerably from the sample previously examined, but it still resembles the "heavy" vetiver oils produced in Europe, rather than the "light" vetiver oil distilled in Réunion.

There is considerable difficulty in getting definite valuations of vetiver oils from new localities at the present time, partly because the supply of vetiver oil has outstripped the demand, and partly because the "light" vetiver oil produced in Réunion appears to be replacing "heavy" vetiver oils to some extent. Apart from these difficulties there is the fact that the value of a vetiver oil is finally decided largely on the commercial expert's personal taste. The vetiver oils produced in different countries no doubt all possess the characteristic vetiver odour, but each has peculiarities of its own, which naturally affect the expert's opinion of its value.

As the present sample of oil received from Fiji was small, it could only be submitted to three experts for trial

and valuation, and the following is a summary of their reports, which serve to illustrate the difficulty there is in arriving at even an approximate valuation of a product when the tests on which reliance is placed are purely subjective:

(1) A sample of the oil was submitted to a German firm of essential oil distillers, who examined it, and reported that although not quite equal to the best vetiver oils produced in Europe it was of good quality and should realise a wholesale price of 25*s.* to 30*s.* per lb., landed terms (June 1913). They added that there is only a restricted demand for vetiver oil, and that in their opinion this demand is amply met by existing sources of supply.

(2) A firm of oil distillers in London reported that the constants of the oil were about normal, but that the odour was considerably inferior to that of Indian vetiver and more resembled that of Bourbon (Réunion) oil, though it was inferior to the latter. The firm stated that it was difficult to estimate the commercial value of the oil, but they were of opinion that it would be worth about 16*s.* per lb. in London (July 1913). They pointed out that there is not a great demand for vetiver oil, and that if it were produced on a large scale a considerably lower price would have to be accepted for it. The value of Bourbon vetiver oil on the same date was about 30*s.* per lb. in London.

(3) A London dealer in essential oils reported that the oil appeared to be of good quality, but that it was difficult to estimate its value. He was however of opinion that the oil was not of sufficient commercial interest to find a large market.

Oil of Limes from Fiji

A sample of distilled oil of limes was also received from Fiji in April 1913. The oil was pale yellow in colour and possessed the characteristic odour of distilled oil of limes. It was examined with the following results, which are compared with those recorded for West Indian distilled oil of limes:

	Present sample.	West Indian distilled oil.
Specific gravity at $\frac{15°\,C.}{15°\,C.}$	0·868	0·856 to 0·868
Optical rotation α_D at 21° C.	+ 37° 6′	about + 40°

This oil closely resembled the ordinary distilled oil of limes imported from the West Indies, the current value of which on the date of the report was from 2*s.* 6*d.* to 2*s.* 9*d.* per lb. in London (December 1913).

Ylang-Ylang Oil

Seychelles

The results of examination of three samples of ylang-ylang oil from the Seychelles have been published previously in this Bulletin (1908, **6**, 110). Further samples were received in May 1909 and November 1913 respectively, and an account of the results of examination of these is given below.

The oil received in 1909 was pale yellow, faintly cloudy, and possessed the characteristic odour of oils derived from the flowers of *Cananga odorata*. It furnished the following constants on examination:

Specific gravity at 15° C.	0·920
Optical rotation α_D at 21° C.	− 30°
Saponification value	46·4
Acid value	4·2
Ester value	42·2
Solubility in 90 per cent. alcohol	1 in 1, but not more

The results of the chemical examination of the oil show that its constants do not agree with those of true ylang-ylang oil, but with those of cananga oil, and no firm which purchases essential oils on the basis of chemical examination would accept this Seychelles oil as a true ylang-ylang oil.

The oil was submitted for valuation to experts in this country and on the continent; but considerable difference of opinion was expressed as to the character of the oil. Two firms regarded it as cananga oil, and one of these valued it at 8*s.* per lb. in the crude state. Another firm, however, regarded it as ylang-ylang oil, though not so delicate or refined in odour as the Manila product. This difference of opinion, as to the category in which this oil should be placed, is probably explained by the circumstance that the third firm referred to appear to have valued the oil on its odour alone.

A portion of the oil now under report was re-examined after a lapse of over three years, in order to ascertain whether it had altered to any considerable extent. The results showed, however, that the oil had not changed very greatly since it was first examined, the only noteworthy feature being that the ester value showed a slight increase (see next table).

The sample received in 1913 consisted of bright, pale yellow ylang-ylang oil. It was examined with the following results, compared with the corresponding figures for the previous sample from Seychelles.

		Previous sample.	
	Present sample.	First examination.	Second examination, after keeping for over three years.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9567	0·9200	0·9250
Optical rotation α_D	− 28° 5′ at 20° C.	− 30° at 21° C.	− 28° 36′ at 24° C.
Acid value	3·3	4·2	2·6
Ester value	126·0	42·2	53·5
Saponification value	129·3	46·4	56·1
„ „ after acetylation	181	—	—
Solubility in 90 per cent. alcohol	Gives a clear solution with less than 0·8 vol.; with 0·8 vol. or more, becomes turbid.	Soluble in 1 vol.; becoming turbid with a larger quantity.	Soluble in ½ vol.; becoming turbid with 1 or more vols.

The present sample of oil differs markedly from the previous sample in containing a very much larger percentage of esters, and in having a higher specific gravity. Its constants agree with those recorded by Bacon for first-grade Manila ylang-ylang oil, as will be seen from the following figures:

	First grade.	Second grade.
Specific gravity at $\frac{30^\circ C.}{4^\circ C.}$	0·91 to 0·96	0·89 to 0·94
Optical rotation α_D at 30° C.	− 48° to − 26°	− 87° to − 27°
Ester value	90 to 169	42 to 89

It is thus clear that so far as constants are concerned this oil is more like a first-grade Manila ylang-ylang oil than the previous sample from Seychelles. Its odour,

however, on which the value of the oil finally depends, is not altogether pleasant, and is rather pungent.

In view of the smallness of the sample, and of the impossibility of obtaining supplies of the oil from Seychelles at present, it was not submitted to experts for valuation. It should, however, be pointed out that owing to great over-production of the oil, it is very difficult at present to sell ylang-ylang oil at remunerative prices unless it is of the first grade.

Mauritius

A sample of ylang-ylang oil from Mauritius was received in June 1913. It consisted of a turbid yellow oil, having a characteristic pleasant odour. The oil was examined with the following results:

Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9883
Optical rotation α_D at 20° C.	−30°
Acid value	7
Ester value	173
Saponification value	180
„ „ after acetylation	211
Esters, expressed as acetate of $C_{10}H_{18}O$, *per cent.*	60·55
Alcohols, *free*, expressed as $C_{10}H_{18}O$, *per cent.*	10·76
„ *combined* „ *per cent.*	47·58
Solubility in 90 per cent. alcohol	The oil gave a clear solution with 0·1 to 2·5 vols., becoming turbid on further dilution.

The above results indicate that the constants of this oil are somewhat abnormal when compared with those of the best grades of ylang-ylang oil (see table on p. 229), the specific gravity and ester value being higher than the figures usually found for the latter oils.

Samples of the oil were submitted to two firms of essential oil merchants in London, and also to two Continental firms, with the following results:

(1) One of the London firms reported that the oil possessed characteristics distinct from those of any ylang-ylang oil which they had examined previously, or of any

oil for which figures have been published. They stated that such characteristics in ordinary ylang-ylang oil would be regarded with suspicion, and they would not accept this product as a substitute for the normal ylang-ylang oil. They added, however, that the odour was good, and that the peculiar characteristics were probably due to the district in which the oil was produced; and, regarding it as a pure oil, they valued it on its merits at about 4*s.* per oz. The firm added that this Mauritius oil would not of course compare in odour with the finest ylang-ylang oil from Manila, the current value of which was about 12*s.* to 13*s.* per oz. in London, according to the brand (December 1913).

(2) The second London firm reported that in their opinion the sample was of very good quality, but that as the market is overloaded at present probably not more than 3*s.* per oz. could be obtained for the oil (December 1913). They added that if the oil was available in commercial quantity they would be prepared to purchase it at about this price.

(3) A firm of distillers in France reported that the odour of the oil was not very delicate, and suggested that this defect was perhaps caused by carrying the distillation of the flowers too far. They were of opinion that such oil would not be saleable in the present state of the market.

(4) A German firm considered the sample to be of indifferent character, and barely equal to what is commercially regarded as middling quality ylang-ylang oil. They stated that there has been heavy over-production in the lower grades of this oil in recent years in Réunion and elsewhere, and that consequently it has become very difficult to dispose of anything but first-grade oils at remunerative prices.

In view of the foregoing reports it appears that under present conditions ylang-ylang oil of the quality of the sample under report would probably not realise more than about 3*s.* to 4*s.* per oz. in the London market. It was suggested, therefore, that efforts should be made in Mauritius to produce an oil of superior quality by careful

attention to the degree of ripeness of the flowers, and the regulation of the distillation.

Clove Oil from Mauritius

Two samples of clove oil from Mauritius were received in September 1913.

No. 1.—This was a pale reddish-brown oil, possessing the strong aromatic odour and pungent taste characteristic of oil of cloves.

No. 2.—This oil closely resembled sample No. 1, but was superior to it in odour. It was slightly cloudy owing to the presence of moisture.

The samples were submitted to chemical examination with the following results, which are shown in comparison with the range of constants recorded for commercial clove oil:

	No. 1.	No. 2.	Commercial clove oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	1·061	1·067	1·047 to 1·070
Optical rotation a_D at 22° C.	− 0° 10′	− 0° 5′	0° to − 1° 30′
Eugenol . . *per cent.*	89	95	85 to 95
Solubility in 70 per cent. alcohol.	Soluble in 1·5 vol. or more.	Soluble in 1·25 vol. or more.	Soluble in 2 vols.

The oils were submitted to several firms of oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm stated that the oils were dark in colour and lacked "body," but should be saleable for the preparation of eugenol at a price of about ½*d.* per lb. for each 1 per cent. of eugenol present. Thus, an oil containing 90 per cent. of eugenol would be worth 3*s.* 9*d.* per lb. (February 1914).

(*b*) A second firm reported that the odour of the samples was characteristic of clove oil, but not equal to that of the oil distilled in the United Kingdom, whilst the colour of the samples was too dark and the density very high, these remarks being especially applicable to sample No. 2. They were, however, of opinion that the high percentage of eugenol present would render these oils of special value in the preparation of vanillin. The firm added that better

methods of distillation would probably improve the quality of the oils.

(*c*) A German firm reported that the samples exhibited normal properties, and represented clove oils of good commercial value, which should be saleable at about 8 marks per kilogram (February 1914), a value quite similar to that quoted above.

(*d*) A fourth firm reported that the samples were of fair average quality, although they did not consider the aroma to be quite equal to the standard of the best English distilled clove oil, whilst the colour was rather dark, and would in many quarters be considered an objection. They added that the current price of the best clove oil was about 3*s.* 6*d.* per lb. (February 1914), and they therefore valued these Mauritius oils at rather less.

From the results of this investigation it is evident that these Mauritius clove oils, although somewhat inferior in colour and aroma to the best clove oils distilled in the United Kingdom, are nevertheless of good quality. There is no doubt that consignments of such oils would meet with a ready sale in Europe.

The yields of clove oil obtained in these trials in Mauritius appear to have been rather low, viz. 11·5 and 10·2 per cent. respectively, as against an average yield of about 15 to 18 per cent. obtained by the distillation of cloves in Europe. It is possible, however, that the cloves used in these trials in Mauritius were not so dry as those usually imported into Europe.

Clove Leaf Oil from Mauritius

Three clove leaf oils from Mauritius were also received in September 1913.

No. 1.—This was a light reddish-brown oil possessing the strong aromatic odour and pungent taste characteristic of clove leaf oil.

No. 2.—This oil closely resembled No. 1, but was somewhat darker in colour.

No. 3.—This oil closely resembled No. 2.

The samples were submitted to chemical examination at the Imperial Institute with the following results;

	No. 1.	No. 2.	No. 3.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	1·062	1·059	1·065
Optical rotation α_D at 22° C.	− 0° 28′	(Nos. 2 and 3 were too dark for this determination.)	
Eugenol . . *per cent.*	91	90	90
Solubility in 70 per cent. alcohol.	In each case the oil was soluble in 1·25 vol. or more.		

These results agree fairly well with those previously obtained at the Imperial Institute for clove leaf oils from Zanzibar and Seychelles (this BULLETIN, 1908, **6**, 111; 1913, **11**, 438).

The oils were submitted to several firms of oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm reported that the oils were dark in colour and lacked "body." They would, however, be saleable for the preparation of eugenol, and for this purpose should be worth ½*d.* per lb. for each 1 per cent. of eugenol which they contained. Thus, an oil containing 90 per cent. of eugenol would be worth 3*s.* 9*d.* per lb. (February 1914).

(*b*) A second firm placed the samples, according to quality, in the order Nos. 1, 2, 3, No. 1 being the best. They stated that on account of their richness in eugenol the oils should be of value for the manufacture of vanillin, and that if the colour could be improved they should also find a market for perfumery purposes.

(*c*) A German firm reported that the samples exhibited normal properties, and should be worth as much as clove-stem oil, viz. about seven marks per kilogram (February 1914).

(*d*) A fourth firm stated that the value of the oils would be based entirely on their eugenol content, as the samples (especially Nos. 2 and 3) were deficient in aroma and dark in colour; and that their principal application would be in the manufacture of vanillin, for which purpose they would probably realise rather less than the current price of clove oil. The firm added, however, that the actual value of the products could only be ascertained by practical experiments on a manufacturing scale.

The foregoing reports indicate that these clove-leaf oils are of satisfactory quality and would be readily saleable for

the extraction of eugenol, which is largely used for the manufacture of vanillin.

The yield of oil obtained from the clove leaves in these trials in Mauritius appears to be small even under the best conditions, viz. 1·62 per cent. Clove leaves from the Seychelles distilled at the Imperial Institute in 1907 yielded 4·5 per cent. of oil (this BULLETIN, 1908, **6**, 111).

SANDALWOOD OIL FROM MAURITIUS

The three samples of sandalwood oil which are the subject of this report were received at the Imperial Institute in September 1913. They were stated to have been distilled from the wood of *Santalum album*, and it was desired to ascertain their commercial value in Europe.

No. 1 (*pale*) (*from heartwood*).—This was a somewhat viscid oil, of light yellow colour, and possessing the characteristic aromatic odour and taste of sandalwood oil.

No. 2 (*dark*) (*from heartwood*).—This was of similar character to No. 1 (pale), but was of a yellowish-brown colour.

No. 3 (*from sapwood*).—This oil closely resembled No. 2 (dark) in appearance.

The three oils were all slightly cloudy owing to the presence of moisture.

The samples, after the removal of the moisture they contained, were submitted to chemical examination with the following results, compared with the corresponding average figures for commercial sandalwood oil:

	No. 1 (pale).	No. 2 (dark).	No. 3.	Commercial sandalwood oil.
Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$	0·9788	0·9804	0·9814	0·974 to 0·985
Optical rotation α_D at 22° C.	− 21° 19′	− 20° 19′	− 20° 36′	− 16° to − 20° 45′
Acid value	1·4	1·7	2·2	0·5 to 8·0
Saponification value	4·7	3·9	2·8	3·17
Saponification value after acetylation	199·7[1]	203·3[1]	203·0[1]	not below 196[1]
Solubility in 70 per cent. alcohol	Soluble in 5½ vols. or more at 15° C.	Soluble in 5½ vols. or more at 15° C.	Soluble in 5½ vols. or more at 15° C.	Soluble in about 5 vols.
Calculated for santalol $C_{15}H_{24}O$. *per cent.*	93·10	95·02	94·93	at least 90

From these results it is evident that the Mauritius oils contain a satisfactory proportion of santalol, and that, in general, their constants correspond with those of ordinary commercial sandalwood oils.

The three oils were submitted to several firms of essential oil distillers and merchants in the United Kingdom and abroad, who reported on them as follows:

(*a*) One firm reported that the oils were rather dark in colour, and had a somewhat earthy odour. They pointed out that the yields stated to have been obtained in Mauritius, in no case exceeding 1·58 per cent., are very low, the normal yield being about 4 per cent.; and they suggested that the wood was not ground finely enough, and that it would be better to export the wood itself than to attempt to distil the oil in the Colony on a commercial scale.

(*b*) A second firm reported that sample No. 1 (pale) was of characteristic odour, and in their opinion compared favourably with the oil distilled from East India sandalwood, but that the colour of No. 2 (dark) and No. 3 was too dark, and their odour inferior. The firm considered that better methods of distillation would probably improve the colour of these oils.

(*c*) A German firm considered that the oils would compete favourably with good commercial sandalwood oil, and valued them at about 44 marks per kilogram (February 1914), adding that two years ago the corresponding price would have been only 20 marks per kilogram.

(*d*) A fourth firm reported that the samples appeared to be of very good quality, but were rather darker in colour than is usual with sandalwood oil, whilst they would also require filtration. The firm stated that the current market value of good foreign sandalwood oil was 20*s.* to 21*s.* per lb., and that of the finest English sandalwood oil 22*s.* to 23*s.* per lb. in London (February 1914), adding that the prices had risen considerably of late owing to the higher price of sandalwood, the normal value of the oil having been for many years from 10*s.* to 12*s.* per lb. It will be seen that these figures are similar to those quoted by the German firm mentioned above.

These sandalwood oils from Mauritius appear to be, on the whole, of good quality, and there is no doubt that consignments of such oils would be readily saleable in Europe.

COHUNE NUTS FROM BRITISH HONDURAS

A REPORT on cohune nuts was printed in this BULLETIN last year (1913, **11**, 226). The number of the BULLETIN containing the report was sold out very soon after it was published, and as enquiries on this subject are still being received, it seems desirable to reprint the report, so that it may be readily available for general information. An analysis of the meal, left after the extraction of the oil from the kernels, has been made at the Imperial Institute since the report was first published, and the results of this analysis have been added.

Cohune nuts are derived from the cohune palm (*Attalea Cohune*), a native of British Honduras, where it is said to occur over an area of nearly 2,000,000 acres, or two-fifths of the total area of the colony. It is the characteristic plant of the "cohune ridges," a term applied to the low-lying lands bordering river valleys, or occupying extensive tracts or basins, as in the west and south, or at the heads of some of the rivers.

The nuts are borne in large bunches, and each tree is said to yield 1,000 nuts per annum (*Colonial Reports, Annual*, No. 73, *Report on British Honduras for* 1891 [Cd. 6857-23], p. 21). This estimate, however, is probably too low, and in one case brought to the notice of the Imperial Institute the yield of nuts per tree was 2 cwts., *i.e.* about 2,000 nuts. The kernels are rich in oil; but so far they have not been utilised on a commercial scale, chiefly owing to the difficulty of cracking the very hard shells which surround them. Several machines have been devised for this purpose, and certain of these are now under trial in British Honduras.

The oil yielded by the kernels was examined at the Imperial Institute some years ago, and the results pub-

lished in this BULLETIN (1903, 1, 25). Since that date a number of samples of cohune fruits and kernels have been received from British Honduras, and the results of their examination are given in the succeeding pages.

A sample of cohune kernels, measuring about 1¼ to 1½ in. in length, and ¾ to 1 in. in diameter, was received in April 1912. Scarcely any of the kernels were quite undamaged, and many of them were badly damaged. The sample yielded 71·8 per cent. of solid white fat, resembling coconut oil in appearance. As this yield was considerably more than that obtained from the earlier sample, further specimens were asked for in order that the average yield of fat might be determined.

In response to this request three samples of fruits and two of kernels, stated to have been obtained from palms on the Belize River, were forwarded from British Honduras in September 1912. These samples were as follows:

(1) Large brown fruits.—These measured about 2½ to 2¾ in. in length, and about 1½ to 2 in. in diameter; they were rounded at the base and pointed at the apex. The papery, leaf-like bracts had in most cases become detached from the bases of the fruits in transit.

The fruits had a tough outer fibrous layer enclosing the nut; this outer layer was about ⅛ in. thick, and contained a small proportion of fat. The nuts, which measured 2 to 2¼ in. in length and about 1½ in. in diameter, had a hard, woody shell, about $\frac{3}{10}$ in. thick, and extremely difficult to crack, enclosing an oily kernel; occasionally two kernels were present. The kernels, which were about 1 to 1¼ in. long and ⅝ in. in diameter, resembled ordinary palm kernels in general appearance, but were of a more elongated shape. The average weight of an entire fruit was about 50 grams.

(2) Small fruits resembling those of sample 1, but without bracts. The average weight of a single fruit was 45 grams.

(3) Fruits of a rather darker colour, more rounded in shape, and slightly smaller than those of sample 1. The average weight of a single fruit was 48 grams.

(4) Whole kernels.—These resembled those extracted from the fruits of samples 1, 2, and 3. A fair proportion

of broken kernels was present. The average weight of a kernel was 5·2 grams.

(5) Broken kernels.

The fruits of samples 1, 2, and 3 were found to have the following composition:

		No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*
Outer fibrous layer		33·2	15·1	22·6
Nut	Shell	58·0	71·3	66·5
	Kernel	8·6	13·6	10·9

The percentage of kernel in the fruits therefore varied considerably in the three samples.

Outer fibrous Layer.—The percentages of moisture and fat present in the outer fibrous layer of the fruits were determined with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*
Moisture	9·6	8·4	10·2
Fat	16·9	20·6	9·3

It will be seen that the percentage of fat in the outer layer of the fruits of sample No. 3 was much less than the corresponding figures for samples Nos. 1 and 2.

The fat obtained in all three cases had a dark greenish colour which was almost completely removed by treatment with animal charcoal, and the fat was then of a pale greenish-yellow tint. An examination of the fat obtained from the fibrous layers in samples 1 and 2 and decolorised with animal charcoal gave the following results, compared with the range of the principal constants recorded for commercial palm oil:

	Sample 1.	Sample 2.	Commercial palm oil.
Specific gravity at $\frac{100°\text{ C.}}{15·5°\text{ C.}}$	0·848	0·855	0·9209–0·9245
Acid value [1]	162·0	121·3	—
Saponification value [1]	197·4	203·1	196·3–205·5
Iodine value *per cent.*	75·1	65·4	53–57·4
Titer test [2]	31·0° C.	—	35·8° C.–46·4° C. (mostly 44·5° C.–45° C.)
Hehner value [3]	97·0	—	94·2–97
Reichert-Meissl value [4]	1·65	—	0·86–1·87
Unsaponifiable matter, *per cent.*	0·95	—	—

[1] *Milligrams of potash for 1 gram of fat.* [2] *Solidifying point of fatty acids.*

[3] *Percentage of insoluble fatty acids and unsaponifiable matter.*

[4] *Cubic centimetres of decinormal alkali required to neutralise the soluble volatile acid from 5 grams of fat.*

Owing to the bulky and fibrous nature of the outer layer of the nuts, the fat could probably not be obtained by expression, but would have to be extracted by means of solvents; and this process would most likely be unremunerative, especially as the residual fibre would be of little or no value.

Kernels.—The kernels yielded a solid, white, crystalline fat, resembling coconut oil in appearance and smell. The percentages of fat and moisture found in the kernels from the samples of fruits Nos. 1, 2, and 3, and in the samples of kernels Nos. 4 and 5, are given in the following table:

	No. 1. *Per cent.*	No. 2. *Per cent.*	No. 3. *Per cent.*	No. 4. *Per cent.*	No. 5. *Per cent.*
Moisture . .	4·6	4·3	4·2	4·2	4·9
Fat . . .	67·7	68·4	71·6	68·5	65·4

An examination of the fats obtained from these five samples of kernels gave the following results:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Specific gravity at $\frac{100^\circ\text{ C.}}{15{\cdot}5^\circ\text{ C.}}$.	0·870	0·871	0·871	0·868	0·870
Acid value[1]	3·5	13·1	1·2	20·4	12·3
Saponification value[1] . .	255·0	256·5	256·5	252·4	252·4
Iodine value . . *per cent.*	13·6	13·7	11·4	13·7	11·0
Titer test[1]	19·8° C.	21·0° C.	20·2° C.	19·7° C.	—
Hehner value[1] . . .	—	—	—	87·7	—
Reichert-Meissl value[1] . .	6·8	8·3	8·2	7·1	—
Polenske value[2] . . .	—	15·4	—	12·5	—
Unsaponifiable matter, *per cent.*	0·24	0·28	0·23	0·28	—

[1] *For the meaning of these terms see p.* 239.

[2] *Cubic centimetres of decinormal alkali required to neutralise insoluble volatile acid from* 5 *grams of fat.*

For the purpose of comparison a table showing the range of the principal constants of coconut oil and palm-kernel oil is given below:

	Coconut oil from copra.	Palm-kernel oil.
Specific gravity at $\frac{100^\circ\text{ C.}}{15{\cdot}5^\circ\text{ C.}}$.	0·874	0·873
Iodine value . . *per cent.*	8·0–10·0	10·3–17·5
Saponification value . .	246–268	242·4–254·8
Titer test	21·2°–25·2° C.	20·0°–25·5° C.
Hehner value	82·4–90·5	91·1
Reichert-Meissl value . .	6·65–7·5	5·0–6·8
Polenske value . . .	18·0	—
Yield of oil from kernels . .	64·5–74·7	46·7–52·5

The foregoing tables indicate that cohune kernel fat resembles very closely both coconut oil and palm-kernel oil, but is generally of somewhat softer consistency.

Residual Meal.—A sample of the residual meal left after the extraction of the oil from the kernels was examined, and its composition found to be as follows, compared with that of coconut cake and palm-kernel meal (see Kellner, *The Scientific Feeding of Animals*, p. 377); in each case the figures have been re-calculated on a basis of 10 per cent. of fat.

	Cohune nut kernel meal.	Coconut cake.	Palm-kernel meal.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	9·2	10·3	10·0
Crude proteins	21·7	21·0	17·1
Consisting of:			
True proteins	20·3	—	—
Other nitrogenous substances	1·4	—	—
Fat	10·0	10·0	10·0
Starch, etc.	38·8	38·1	35·7
Fibre	15·6	14·5	23·2
Ash	4·7	6·1	4·0
Nutrient ratio [1]	1 : 2·9	1 : 2·9	1 : 3·4
Food units [2]	118	115·6	103·5

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The meal contained no alkaloids or cyanogenetic glucosides.

It will be seen from the above table that the composition of cohune nut kernel meal, calculated on a basis of 10 per cent. of fat, is practically identical with that of coconut cake. Compared with palm-kernel meal the present sample contains a higher percentage of protein and less fibre. Feeding trials with the meal would be necessary, however, to determine the real value of the meal for feeding purposes and to ascertain whether or not it can safely be used as a general feeding stuff for animals.

As already mentioned, the fibrous layer of the cohune fruit is not likely to be of value under present conditions

for the fat it contains. If, however, at some future time plant for the extraction of fat from cohune kernels by solvents were installed in British Honduras, the question of recovering the fat from the fibrous layer of the fruit would be worth consideration.

The cohune kernels yield about the same percentage of fat as copra, and rather more than palm kernels. If shipped to Europe in commercial quantities and in good condition, they should therefore realise prices approximating to those of copra. The present prices of copra in the United Kingdom are approximately from £23 10*s.* to £24 17*s.* 6*d.* per ton (June 1913).

The cohune kernel fat should be worth about the same price as palm-kernel oil or coconut oil, the present values of which in the United Kingdom are as follows: coconut oil from £40 to £50 per ton, and palm-kernel oil about £37 10*s.* per ton (June 1913). It is not possible, however, to give a definite commercial valuation of cohune kernel fat until it has been submitted to technical trial on a large scale.

SPECIAL ARTICLE

COFFEE CULTIVATION IN UGANDA

By W. Small, M.A., B.Sc.,

Botanist, Department of Agriculture, Uganda

Coffee is the staple crop of European planters in Uganda. Six years ago the amount exported was only 194 cwts., valued at £194; but during 1912–13 the amount rose to 3,336 cwts. and value to £8,940. The area under coffee at the end of March 1913 was 4,568 acres, and under coffee and rubber 2,659 acres. In spite of the rapid progress thus made the area under coffee is still being extended, and the value of the exports during the nine months ended December 31, 1913, was £16,852. This large increase is due to coffee estates coming into bearing for the first time during 1913. Other estates have not yet begun to bear, so that a further large increase in the amount and value of coffee

exported may be confidently looked for in each of the next few years.

It is a question whether the maximum output, when once attained, will be maintained over a large number of years. Among the factors governing the future of the industry the chief will be the prevalence or scarcity of diseases and pests, and the amount of success achieved with other Uganda crops, such as cocoa and rubber. Cotton growing is almost entirely in native hands, and is not in favour with European planters; at present the possibility of Uganda following the example of Nyasaland, and making a success of cotton planting under European management, seems remote.

Varieties of Coffee in Uganda

The indigenous coffee of Uganda is *Coffea robusta*. It occurs throughout the Kingdom of Buganda and certain other parts singly or in groups of from three to twelve trees, and though, to all appearances, it grows well and bears heavy crops, it is capable of improvement by good cultivation. These indigenous trees are usually heavily shaded by bananas, bark-cloth trees, and the like, and leaf disease (*Hemileia vastatrix*, B. and Br.) is rife. The native owner pays no attention to the trees beyond picking the ripe berries. The produce is consumed locally. This "native" coffee was grown originally in specially cleared strips of forest, and the largest output came from the Sese Islands, a group in Lake Victoria (Victoria Nyanza), visible on the horizon from the shores of the Kingdom of Buganda. It was only when the natives realised that this coffee was of economic value that they planted it in their own gardens, as it is found at the present day.

The coffee cultivated by Europeans in Uganda is of two kinds—"Nyasaland" and "Bourbon." It is said that the "Bourbon" sort came from Aden, *via* the Île de Bourbon, to East Africa, transported thence by French missionaries, and that the "Nyasaland" coffee was derived from the "Blue Mountain" coffee of Jamaica, introduced into Nyasaland and thence into Uganda some dozen years ago. If

credence can be given to these statements, both these coffees are to be regarded as derived from *Coffea arabica*, L.

Little care has been taken as regards seed-selection; much inferior seed has been planted, and in some areas inequalities of growth are very noticeable. The demand for seed, caused by the recent opening-up of new land, was met by local supplies from the older plantations, particularly from those in the hands of the missionaries, who did valuable pioneering work. Both "Bourbon" and "Nyasaland" sorts of coffee thrive well in Uganda, and give heavy crops in the fourth year.

The outbreak of coffee-leaf disease at the end of 1912, and the epidemic during the rainy season, March–May of 1913, led planters to give some attention to other kinds of coffee. *C. liberica*, Hiern, is not immune to leaf disease, and it is doubtful whether it will thrive in Uganda. Its product is inferior to that of Arabian coffee. Moreover, it requires a rich soil, a hot, moist atmosphere, and a lower elevation than that obtaining in this country. Plants of *C. liberica* and *C. stenophylla*, G. Don, are being raised by the Department of Agriculture from seed imported from West Africa, and their progress will be watched with interest. A few acres have been planted with *C. robusta*; but enthusiasm for it is lacking, and it is very unlikely that it will ever become a favourite crop.

Climate, Soil, and Situation

The Uganda Protectorate is situated within the zone usually regarded as providing the best conditions for coffee-culture. The climate and soil are matters of primary importance, and in both of these respects the conditions in Uganda are favourable. There is much rich, deep soil of free texture which is very suitable for coffee. Potash is an essential constituent of a good coffee soil, and it is present where forest has been felled, or where the grass-land, so common in this Protectorate, has been cleared. Coffee land should be well drained, and stagnation of soil-water is as undesirable for coffee as is a stiff clay subsoil. The contours of the planting districts in Uganda favour easy drainage, for gentle slopes are more usual than steep

declivities, and flat, swampy land can always be avoided. Similarly, the intending planter should keep clear of excessively humid or excessively dry areas. A long, dry season is very trying to coffee plants, and a wet atmosphere, due to excessive rainfall or the nearness of marshy places, results in the production of luxurious growths of wood and foliage, to the detriment of the crop. Well-established coffee, however, does stand a considerable degree of heat, so long as it has sufficient moisture. It must be remembered also that a sufficient elevation will render temperate a region which is situated on the Equator itself. This is often the case in Uganda, and, on the whole, the climate, elevation, and general conditions are eminently suitable for coffee cultivation.

As has been said, gradual slopes are a feature of the areas already devoted to coffee-planting in Uganda. The most suitable areas are those which are free from sour material and possess sufficient incline not to retain an excess of moisture, and are yet not steep enough to allow heavy rain to denude the land of its valuable surface soil. In many cases the action of natural forces has formed at the base of a slope, or on its lower parts, an accumulation of soil which is permanent, and contains much organic matter produced by the decay of vegetation from the surrounding hills.

Heavy forest land is not usual in the planting districts, but where it does occur—for example, in occasional patches in hollows—it can be thinned and retained as a field or nursery shade. Most of the land acquired for coffee estates bears "elephant grass" (*Pennisetum purpureum*, Schum.), which grows thickly, and often to a height of over 12–15 ft. The clearing of such land consists in cutting and burning the grass, turning over the soil to expose and kill the grass-roots, and finally, removal of the debris.

Manures

It is unlikely that the good coffee land of Uganda will require to be manured for some years to come for the sole purpose of supplying to an exhausted soil the elements it requires. In parts, trees suffer because of denudation of slopes, and in such cases the application

of manure, combined with efforts to replace lost soil and to prevent further loss, is effective. At present all that is needed in the Uganda plantations is that treatment should aim at providing the trees at the proper time with such a stimulus as will enable them to carry through the wet season, with its dangers of the spread of *Hemileia* disease, and through the dry season, with its dangers of drought and defoliation. Animal dung is so scarce as to be negligible as a manure, and the price of artificial manures is prohibitive. Planters are therefore compelled to use green manures and vegetable refuse such as coffee pulp. Mulching could be advantageously practised to a much greater extent than is yet the case.

Sowing and Planting

For sowing purposes, only the largest and finest fruits from the healthiest trees should be chosen. After hand-pulping and sun-drying the seeds are sown in rows in beds laid down on gently-sloping virgin soil, which has been thoroughly dug and prepared. Sowing by scattering has been practised, but this method leads to a waste of seed and of space. Coffee seedlings have been raised without shade or watering, but it is more usual to have them shaded and watered, and to harden them off, as the time for planting-out comes on, by removing the shade and reducing the water supply. Sowing at stake has not been tried; it avoids the risk and expense of transplanting, but it exposes the young plants to the dangers of heat and drought, and is expensive because of the necessity for continued clean-weeding. Blanks are supplied by potted plants from the nursery.

Lining presents no difficulties except those due to unevenness of ground. The size of the holes varies with the soil. Some planters standardise their holing by using a kerosene tin, fitted with a handle for convenience, as a gauge of size, the hole being made large enough to allow of the tin being turned round in it.

Planting-out is a critical operation, but the planter who organises his labour for the various parts of the

process and endeavours to make his men realise the importance of their work, will have few losses, provided that he is fairly fortunate in weather conditions. A little temporary shade is always advisable for newly planted coffee. It is usually made with the leaves of a palm, *Phœnix reclinata*, Jacq. (native name " nkindu ").

Planting distances should vary according to the quality of the soil, the exposure, and the presence or absence of insect pests and fungoid diseases. Allowance should be made for growth and facility of cultural and other operations. Planting has been too close in several cases. The presence of coffee-leaf disease and the consequent necessity for spraying operations have modified opinion to some extent, and, although 8 x 6 ft. is a favourite spacing, it seems best to plant at least 8 x 8 ft. as a general rule. Triangular planting is rarely found in Uganda. Its advantages are purely theoretical, and the arrangement interferes with inspection and the apportionment of tasks.

Shade Trees and Wind Belts

The question of permanent shade for coffee in Uganda is an unsettled one. Perhaps it is more correct to say that the coffee-growing industry of the country is yet too young to allow of any definite deduction from experience as to whether shade is necessary or unnecessary. Shading has not been given a fair trial, though a few experiments have been made. The results of these were, on the whole, unsatisfactory, possibly because the shade was of too heavy a nature and of such materials as inhibited the circulation of air about the plants, particularly during the night, when the atmosphere is apt to be moist. Shade is advisable on slopes where heavy tropical rains cause erosion and denudation, and it would prove advantageous on wet soils. Its cover aids decay of vegetable matter on the surface, and leguminous shade trees enrich the soil. On the other hand, shade is conducive to a diminished yield and to dampness, and in order to be a protection against infection by *Hemileia* disease by wind-borne spores, it would

require to be so heavy as to interfere seriously with yield and with the movement of the air. It cannot be regarded as a direct protection against *Hemileia* infection; its benefits in this respect are indirect in so far as its presence will induce a vigorous condition of the shaded plant. Further, shade requires to be carefully regulated, and the expense entailed would probably be out of proportion to the benefits afforded. On the whole, lack of experience precludes the statement of a definite opinion at this stage, but it is strongly felt that shade for Uganda coffee is worth an extended trial. The silky oak, *Grevillea robusta*, A. Cunn., is being experimented with for this purpose, and various species of leguminous trees would be suitable. Para rubber trees are used as shade on several estates. They have the advantage of being profitable and the disadvantage of being subject to a root disease (*Hymenochæte noxia*, Berk.) which occurs also on coffee. Cases of this disease have occurred in Uganda, but not frequently, on both coffee and *Hevea*.

Owing to the situation of Uganda, the question of exposure to sunshine is a simpler one than that of exposure to winds. The latter demands consideration. In parts, *e.g.* those near Lake Victoria, strong, steady winds occur at certain times. In some cases they have blasted the exposed trees on one side, and even so loosened them in the soil as to cause eventual death. Remedial measures, however, can be adopted in such cases.

There is no lack of suitable trees for either a high or low wind-belt. Bananas are extensively used. They grow thickly, and they provide food for the native labour staff. Only one indigenous tree (*Dolichandrone platycalyx*, Baker), occasionally used in this connection, is known to harbour coffee pests.

Weeding and Cover Crops

In several cases weeding has proved an expensive item in estate management. Conditions very often favour the rapid growth of weeds, and lead to their becoming a more or less temporary menace to coffee cultivation, but the

real source of expense and trouble lies in the lack of thorough initial clearing and the continuance of operations on scientific lines. Hand-weeding with forks is the most efficient method of procedure. Cover-crops are not much in favour. The remarks made concerning shade apply to cover-crops, and the Department of Agriculture is making trials with various plants.

Pruning

Good pruning enables the trees to bear better crops, and tends to lessen the dangers and effects of leaf disease. Unpruned trees become thickly-entangled masses of branches and leaves, and the chambers so formed about the trunks are a series of forcing-houses for the development of *Hemileia* spores. The planter should never be afraid of sacrificing a portion of his crop. By pruning he will strengthen his trees, prolong their lives, and ease the labours of subsequent years. The difficulties in the way of accomplishing the pruning of a large estate are great. Chief among them are expense and labour, but that they are not insurmountable has been proved.

Pests and Diseases

The "Bourbon" and "Nyasaland" varieties of coffee are, unfortunately, rather susceptible to *Hemileia* disease. The recent virulence of the attack may be explained on the assumption that the parasite, endemic in the country, suddenly found itself in the midst of a generous supply of fresh hosts owing to the rapid planting-up of large areas of coffee. Its attack was able to assume epidemic proportions unchecked. Despite the prevalence of this disease, the outlook is favourable, for the indications are that its virulence will be less in the future than in the past. Planters are recognising that much depends on their efforts to eradicate it, and the Department of Agriculture is alive to the situation. The fungus, being endemic in Uganda, cannot be expected to work the havoc that it has wrought in other countries into which it was introduced.

Exterminators have been used with success in dealing

with those common tropical pests "white ants" (*Termites*). Their ravages are much greater in certain districts than in others, while, in some parts, they have caused little or no damage to growing plants. Their presence is a danger, the gravity of which is not recognised by all concerned, and against which provision should be made.

Harvesting and Preparation of the Berries

Native labourers can pick the coffee crop efficiently after a little instruction, and many estates are now erecting machinery for pulping and drying coffee. Fermentation is done in tanks, and the first part of the drying process is accomplished by spreading the beans on wire trays in the sun. Climatic conditions often interfere with the sun-drying process, for harvesting takes place during the wet season. A hulling and sizing factory is about to be established in Kampala, the commercial capital of Uganda. Such work is best left to those who make a speciality of it.

Good prices have been obtained under conditions far from perfect, and the gathering of experience and subsequent improvements in methods should in time raise the standard of quality of Uganda coffee. In the meantime, the prospects of the industry cannot be regarded as other than bright.

[*Note by Editor.*—In view of the promising condition of coffee cultivation in Uganda described by Mr. Small, reference may be made to a report on plantation coffees from Uganda published in this Bulletin two years ago (1912, **10**, 397). The results of the examination of these coffees in the Scientific and Technical Department of the Imperial Institute showed that they were of very promising quality, being valued at 70*s.* to 72*s.* per cwt., with Nyasaland coffee at 76*s.* to 82*s.*, and Central American coffees at 77*s.* to 85*s.*

Such defects as the Uganda coffees exhibited were those due to inexperience in preparing the beans for the market. Recommendations for avoiding these defects were made, and it was pointed out that with more experience an excellent quality of coffee should be produced by the Uganda planters.]

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

THE UTILISATION OF FISH AND MARINE ANIMALS AS SOURCES OF OIL AND MANURE.

PART I.—OILS.

ALTHOUGH fish of many kinds have been used as manure since early times, the industrial manufacture of fish oil and fish manure is comparatively modern. Whaling and the manufacture of whale oil, however, have been carried on for many centuries.

The development of the fish manure industry is due to a variety of causes, such as (1) the utilisation of edible fish when the supply exceeds the demand; (2) the utilisation of inedible fish; (3) the disposal of fish waste, such as livers, heads, and offal obtained as waste products in the canning, drying, and curing of fish.

The fish oil industry has arisen as an offshoot of fish manure manufacture, owing to the necessity for eliminating oil and water so that the fish may be obtained in a dry, non-putrescible form suitable for storage and subsequent use as manure.

FISH OILS

Roughly speaking, the flesh of fish having livers rich in oil, *e.g.* cod, is almost devoid of oil; whilst fish with oily flesh possess livers which only contain a small amount of oil. The oils obtained from fish may consequently be divided into (1) *Fish-liver oils*, the most important being cod-liver oil, and (2) *Fish-body oils*, of which menhaden and herring oils are produced in large quantities.

The preparation of either of these two classes of oil can be effected by several means; the oldest method is to allow the tissues to ferment in masses, when the oil exudes and can be collected. This is a crude method, which has been used from the earliest times; a variety of devices being employed to facilitate the separation of the oil. An improvement on this method is to boil the fresh fish with water in pans over a fire, when the oil rises to the top

and can be skimmed off; it is advisable also to submit the residual boiled fish to pressure in order to obtain a good yield of oil and a pressed product suitable for use as manure, and free from any large quantity of oil. This can be effected by small hand-screw presses.

It is difficult to produce a high-grade oil of uniform quality by such means, as the process is slow, and the fish is liable to deteriorate before use. Further, the use of fire-heated pans may cause charring with the production of a dark-coloured oil; but this can be obviated by the use of water or steam-jacketed pans or of live steam. The crude oil produced is admixed with water containing soluble matter ("glue"), and is separated by decantation, boiling, and filtration.

Such methods as these are only suitable for use on a comparatively small scale, and have been replaced by large modern machinery in the menhaden oil and similar industries; but they are still useful in localities where small and intermittent supplies of fish are available, or where labour is cheap.

Modern factory methods of preparing fish oils are described under cod-liver oil (p. 255), and will be considered further in the later part of this article dealing with fish manures. Extraction of dried fish by volatile solvents such as light petroleum is also employed to some extent for the preparation of oil (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, London, 1909, ii., 337).

Composition and Uses of Fish Oils

Fish oils, like vegetable oils, consist of glycerides of fatty acids, and, like them, are employed in soap and glycerin manufacture; fish oil "stearins" of pale colour can be used in the manufacture of soap of fair quality, while the lower grades of fish oils can be used directly for making soft soap, or, after hardening by "hydrogenation" (see this BULLETIN, 1913, 11, 660), for hard soaps. Most fish oils readily absorb oxygen from the air, as is indicated by their high iodine value, but they do not dry so rapidly as linseed oil, and do not yield as a rule sufficiently tough or

transparent films to render them suitable for paint manufacture. Some fish oils can be used, however, in admixture with linseed oil for paint manufacture. The fact that fish oils absorb oxygen readily and become gummy renders them unsuitable for lubricating purposes. They are still used to some extent as illuminants.

Fish and fish-liver oils are largely used in the leather trades for the manufacture of chamois leather and for dressing and currying leather, with the object of rendering it soft, supple, and waterproof. For these purposes emulsions of the oils are prepared with soap solution, egg yolk, etc. These mixtures are applied to the leather either in a dry or moist condition by hand or by mechanical means. Chamois or "wash" leather is leather prepared solely by means of oil, generally cod-liver oil. In the manufacture of chamois leather the delimed skin, usually split sheepskin, is treated with cod-liver or other fish oil and either packed in boxes and allowed to heat owing to spontaneous oxidation of the oil, or hung in warm stoves, the oiling and oxidation being repeated until the skin is sufficiently "tanned." The excess of oil is removed from the skin either by dipping in hot water and pressing, when the oil which exudes is termed "dégras" or "moellon," or by treatment with potash or soda solutions, in which case the oil is recovered by means of acids, and is termed "sod" oil. Both "dégras" and "sod" oils are used over again in leather dressing; in fact, the demand for the former is so great that some factories carry out "chamoising" solely for the purpose of obtaining it, the skins being oiled and oxidised over and over again until worn out. Fish oils are also employed in tempering steel. Large quantities of certain oils are employed for "batching" jute and other fibres. The process of batching consists in treating the fibre before spinning with mixtures of fatty and hydrocarbon oils, soap, and water, the object being to render the fibre soft, supple, and suitable for spinning. Whale oil is largely used for this purpose, but fish oils are also employed.

The possibility of using fish oils for food purposes depends on the removal of the fishy taste and smell. The

solution of this problem has often been attempted, and is the subject of many patents. It seems probable that the recently introduced process of hardening liquid oils by hydrogenation (*loc. cit.*) may prove effective, as it is stated (*Journ. Soc. Chem. Ind.*, 1912, **31**, 1165) that the odour of fish and whale oils may be completely removed by this means.

Cod-liver Oil

The preparation of oil from the livers of the codfish (*Gadus morrhua*) was a natural result of the necessity for finding some use for the large quantities of livers obtained as a by-product of the salted and dried codfish trade. The shoals of cod frequent the northern seas, principally around the coasts of Norway, the British Isles, and the northern coasts of North America. The principal centres of the cod-liver oil industry are Norway and Newfoundland, while more recently the cod fishery has assumed importance on the Alaska coast, and has also been undertaken by the Japanese in the Sea of Okhotsk. In Norway the fishing season at the Lofoten Islands, where the finest medicinal oil is manufactured, takes place during the early part of the year, while the fish appear farther north, at Finmarken, in June. The fish are caught either by hook and line or by trap-nets, a method used to great advantage in the narrow fiords.

Cod-liver oil was at first produced by extremely crude methods, such as piling the livers in heaps or in barrels, and collecting the oil which exuded as the livers underwent decomposition. The first portion of oil obtained by this means was of pale colour, and not very unpleasant in odour or taste, but the later portions became increasingly dark in colour and offensive in smell. Consequently several grades of oil were produced which do not appear on the market now, owing to improved methods of manufacture.

At the present time cod-liver oil may be roughly divided into three classes: (1) medicinal cod-liver oil; (2) cod oil (cod-liver oil for technical use); and (3) "coast cod oil," prepared from cod livers admixed with livers of other fish. Medicinal cod-liver oil is prepared chiefly in the Lofoten Islands, Norway, from the livers of cod

brought by steam trawlers to the shore factories as soon as possible after the fish are caught. On arrival at the factory the fish are cleaned, and the livers removed and sorted, any damaged or diseased livers being rejected. The livers are then placed in tin-lined vessels heated by live steam or by steam-jackets. Under these conditions the cells of the liver are broken up, and the oil, which separates rapidly, is run off. Plant for treating the livers on board the trawlers immediately the fish are caught has been devised, and appears to be used to some extent where the fishing-grounds are far from shore.

The livers contain about 50 per cent. of oil, but the yield of oil varies considerably with the condition of the fish from year to year, with consequent fluctuations in the market prices of the oil. The following table shows the variations in the annual output of oil from Norway compared with the number of cod caught (*Ann. Rept. Marine and Fisheries, Newfoundland*, 1912, Appendix, p. 56):

Year.	Cod.	Oil.	Average price of oil, f.o.b. Norway.
	Millions.	*Barrels.*	*Per barrel.*
1902	45	22,500	£7 4*s.*
1903	48	2,800	£24 13*s.*
1911	64	43,300	£5 7*s.*
1912	99	76,200	£2 18*s.*

This crude oil is purified by filtration, and bleached by means of fuller's earth, or by exposure to light in closed vessels. The stearin, which would cause the oil to congeal at winter temperatures, is removed by freezing the oil and filtering, and is sold as fish stearin for soap-making.

The unsound or tainted livers which have been sorted out are worked up by similar processes, and yield a lower grade of darker-coloured oil, which is sold usually under the name "cod oil," and is used for technical purposes; the quality of such oil is superior to that formerly produced on account of the improved methods of manufacture, and the fresher state in which the livers reach the factory, owing to the use of steam trawlers.

The name "coast cod oil" is applied to oil prepared from the livers of cod mixed with those of other fish, such

as hake (*Merluccius vulgaris*), haddock (*Gadus æglefinus*), coal fish (*Gadus* sp.), etc.; this oil is also used for various technical purposes.

Large quantities of cod-liver oil are produced in Newfoundland, and although modern machinery and methods similar to those employed in the Lofoten Islands have been introduced, and high-grade medicinal cod-liver oil has been prepared, it appears that the higher price obtained for such oil is not sufficient to warrant the extra trouble necessary, and that only oils for technical use are now being produced in large quantity.

Pure medicinal cod-liver oil is a pale yellow liquid oil, with a slight fishy odour, and a not unpleasant taste; it has the following constants (Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, 1909, ii., 354).

Specific gravity at $\frac{15^\circ\ C.}{15^\circ\ C.}$	0·922–0·927
Saponification value	182–187
Iodine value . . . . *per cent.*	159

The constants of the technical grades of cod-liver oil vary somewhat according to the methods employed in manufacture, the amount of stearin removed, etc.

The high prices which have sometimes prevailed for medicinal cod-liver oil have rendered it liable to adulteration with other fish-liver oils, fish oils, and whale oils, the detection of which is difficult, and often impossible; but such adulteration is infrequent under present conditions.

The present price of medicinal cod-liver oil is about 100*s.* per barrel in London, while Newfoundland cod-oil is valued at £22 per ton in Glasgow, and "Pure East Coast" oil at £16 15*s.* per ton in Hull.

In 1911–12, 2,578 tons of cod oil, valued at £58,896, were exported from Newfoundland, and in addition 51,227 gallons of refined oil, valued at £8,695, were also exported. The amounts and values of steam-refined cod-liver oil exported from Norway during recent years are as follows:

	1910.	1911.	1912.
Quantity, tons	4,063	4,143	6,554
Value, £	187,478	206,267	206,922

Other Fish-liver Oils

Among the other fish-liver oils of commerce are dog fish, shark, and skate liver oils. In many cases the livers of such fish are not kept separate from the cod livers, but are used together for the manufacture of "coast cod oil" (see p. 255). Dog fish are of particular importance in this connection on account of the damage which they cause by eating valuable edible fish, driving the shoals from fishing grounds, and breaking nets and lines (*Document* No. 622, 1906, p. 40, *U.S. Bureau of Fisheries*). The flesh of dog fish is eaten frequently in some localities, but a prejudice appears to exist against it, and the dog fish caught are not used to any considerable extent for food. Consequently, although they are not so prolific as most fish, producing not more than fifteen young in a season, they have increased in number to such an extent in some localities as to menace the fisheries seriously.

The oils derived from the livers of shark, skate, and dog fish are very similar to cod-liver oil, and are used as adulterants of, or substitutes for, cod-liver oil for technical purposes.

Sharks of various kinds are found all over the world, but the sleeper shark appears to be the species most commonly killed for the production of oil, the most important fishery being that off the coast of Norway, while this species is also killed off the coasts of Iceland and other countries for the sake of the oil (*Rept. of Commissioner, U.S. Commission of Fish and Fisheries for* 1902, p. 227). It is a large fish, measuring up to 25 ft. in length, and when taken in the autumn yields 12 to 50 gallons of oil.

A larger species, the basking shark, is said to yield from 80 to 200 gallons or even more oil.

Experiments have been made recently in Malaya in the production of oil from the livers of sharks which come into the lagoons to pair, when they can be easily speared there; a shark 11 ft. in length yields about 15 gallons of oil (*Journ. Roy. Soc. Arts*, 1912, **60**, 692).

Menhaden Oil

The menhaden (*Brevoortia tyrannus*) is a fish of the herring family or *Clupeidæ*, and frequents the Atlantic coast of the United States from Texas to Cape Cod. Although the flesh is not of unpleasant taste, the species has many bones, and is not used as food to any appreciable extent. Menhaden and similar fish have been used as manure for many years in America, but no appreciable quantity of menhaden oil appeared on the market till about 1860. Since that time the production has increased enormously, and some forty factories are now in existence. The menhaden appears off the coast about April, and in northern waters the fishing season lasts till November; in the Southern States the fishing commences a little earlier, and lasts till the end of December. Catches of fish in southern waters in mid-season are small, most of the fish being taken during the spring and autumn. The fishing is now carried on principally by means of fair-sized steamers carrying crews of about fifty men, or by sailing vessels with auxiliary engines, most of the fish being caught within three miles of shore by means of "purse seines." The method of catching the fish is to surround the shoal with the net, which is thrown out from two boats rowed round the shoal. The nets are about 1,500 ft. long and 180 ft. deep, supported by a row of cork floats at the top, and fitted at the bottom with rings carrying ropes. The rings serve as weights, and also cause the net to form a bag, preventing the escape of the fish when the ropes are hauled tight. When captured the fish are transferred from the net to the ship's hold by means of large dip nets operated by block and tackle.

The larger steamers have a capacity for 750,000 fish (about 220 tons), sailing vessels with auxiliary engines for about 250,000 fish. The fish caught in this way consist almost entirely of menhaden; any edible fish is used by the crew as food, but the quantity obtained is not large as a rule, although sometimes herring and other fish are caught in quantities. Most of the factories now handle the fish by means of automatic elevators and use machinery for cooking

the fish and expressing the oil. Although very large quantities of oil are produced, the manure is of first importance in the menhaden industry, and therefore the methods of obtaining the oil will be dealt with fully in a later portion of this article dealing with the manufacture of fish manure.

The yield of oil obtainable from menhaden varies considerably from year to year, and also with the time of the year; thus the fish often yield little or no oil in the spring, while those caught towards the end of the season yield on an average about 12 gallons, and frequently 15 gallons per thousand. The yield of oil also varies with the locality where the fish are caught, for instance, in 1900 the following yields were obtained:

	Gallons of oil per 1,000 fish.
Rhode Island factories	5·76
New York ,, ...	6·39
Delaware ,, ...	4·92
Texas ,, ...	3·51

The crude menhaden oil produced at the factories varies in colour from light amber to dark brown according to the method of preparation and preliminary purification, and is subjected to the usual processes of separation of stearin, clarification, and decolorisation. When carefully manufactured it is a clear bright oil and should be comparatively odourless and tasteless. It has the following constants (Lewkowitsch, *loc. cit.* p. 340.)

Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$ . . .		0·927-0·933
Saponification value		188·7-193
Iodine value	*per cent.*	139·2-172·6

The use of menhaden oil for paint appears to be on the increase in the United States, and according to Toch (*Journ. Indust. and Eng. Chem.*, 1911, **3**, 627), it is the best fish oil for this purpose, as up to 75 per cent. can be used in admixture with linseed oil, the paint still standing exposure to air well. Its use for painting interiors of buildings is not advisable on account of the unpleasant smell. It is also claimed that paint made with menhaden oil is more resistant to heat than linseed oil paint, and

is therefore suitable for use on boilers and chimneys. It can also be used in printing ink manufacture, and according to Toch (*loc. cit.*) it is more flexible and less liable to crack than linseed oil, so that it can be used for patent leather manufacture, although it produces a peculiar efflorescence when used for this purpose. The most suitable "drier" for use with menhaden oil paints is stated to be a tungate drier (see this BULLETIN, 1913, **11**, 456).

The price of menhaden oil has fluctuated considerably owing to over-production and to other causes, having been as low as 8½*d.* per gallon at one time; recently the prices were 1*s.* 1½*d.* to 1*s.* 2*d.* per gallon for "Northern Crude" and 1*s.* 5½*d.* to 1*s.* 6½*d.* for "White-bleached Winter" oil (*Oil, Paint and Drug Rep.*, June 1913).

Some idea of the great importance of the menhaden oil industry is afforded by the following statistics (*American Fertilizer Handbook*, 1913, p. 68), showing the total production in recent years in the United States:

	1910.	1911.	1912.
Barrels of oil	70,000	135,000	131,089

The average quantity of fish caught during the last thirty years is about 500 million per annum (*Journ. Indust. and Eng. Chem.*, 1913, **5**, 379).

Other Fish Oils

Although the menhaden is probably the only fish which is caught on a large scale solely for the manufacture of oil and manure, enormous quantities of oil and manure are produced from other fish, such as herrings, when these are plentiful.

The herring (*Clupea harengus*), and the related species, sardine, pilchard, sprat, and anchovy, are probably the most important products of the world's fisheries, on account of the large quantities caught for food. As the oil is prepared from the surplus fish, not required for food, and from waste fish, the yearly production of oil varies considerably. Large quantities of herring oil (and manure) are manufactured in Norway and Sweden, where the utilisation of herrings for this purpose has long been

known; over a century ago the Bohuslan fisheries of Sweden produced between one and two million gallons of oil annually (*Report of Commissioner: U.S. Commission of Fish and Fisheries for* 1902, p. 236). The herring is a fish of wide distribution, and herring oil is consequently produced to some extent in all the maritime countries of Europe, on the Atlantic and Pacific coasts of North America, in Japan and elsewhere.

In Japan large quantities of fish oil are produced and exported under the name of "Japanese fish oil." The oil appears to be derived chiefly from a species of herring (*Clupea pallasi*) called the "iwashi," and also from sardines and other fish. It has been produced for many years by primitive processes, but improved methods of manufacture are now being employed.

Sardine oil is prepared from the heads, viscera, etc., and from waste fish from the sardine preserving industry. The Madras Fisheries Department has been engaged in recent years in developing the sardine fishery in the neighbourhood of Cannanore, together with the production of oil and manure; an account of the work done in Madras, together with results of analysis of a number of samples of the oil and manure carried out at the Imperial Institute, have been given in this BULLETIN (1914, **12**, 50).

Salmon oil is produced as a by-product of the salmon canning industry of British Columbia, and according to Lewkowitsch large quantities are exported to the United Kingdom for use in the leather industry, but the quantity of salmon oil exported is not given in the official statistics. The oil appears to be derived chiefly from the heads of fish, as the viscera do not contain sufficient oil to render extraction profitable.

In the United States of America halibut heads are also used as a source of oil.

The following table shows the quantities and values of fish and marine animal oils of all kinds exported from Norway during recent years.

	1910.	1911.	1912.
Quantity, metric tons . . .	14,745	24,594	39,139
Value, £	427,772	662,617	781,228

The quantities and values of fish oil exported from Japan during recent years are given in the following table:

	1910.	1911.	1912.
Quantity, tons	17,872	11,588	15,030
Value, £	268,900	187,400	222,100

Marine Animal Oils

The most important oils derived from marine animals are those obtained from the many different kinds of whales and seals; of less importance are the oils derived from dolphins, porpoises, and other aquatic mammals.

Whale Oil

The capture of whales in northern seas was carried on by Norwegians many centuries ago, while the whaling industry of the Basque provinces and Spain, which was important from the tenth to the sixteenth century, was prosecuted so vigorously that the species of whale utilised became almost extinct. In the earlier part of last century whale oils were used for lighting, lubricating, and other purposes to a very large extent, and the large demand for oil led to a scarcity of whales. The substitution of vegetable oils and petroleum for whale oil then led to a falling off in the demand for whale oil, and the industry diminished in importance. The high prices in whalebone, the present large demand for oils of every kind, together with improved methods of whaling and the discovery of new whaling grounds, have however rendered whaling a profitable industry in several parts of the world during recent years. The most valuable part of the whale is the blubber, which is a layer of fat covering the body and lying between the skin and the flesh, and in the larger whales varies in thickness from about 1 in. to as much as 22 in., according to the species, size, and condition of the whale, and contains about 75 per cent. by weight of oil. The blubber of right whales is usually thicker than that of the sperm whale, while that of the smaller whales, such as orcas, belugas, blackfish, and of porpoises, varies from only ½ in. to 4 in. in thickness. Oil is also derived from the lips, tongue, and entrail fat of whales.

The whales or Cetacea are divisible into two main

groups: 1. Mystacoceti, or whalebone-bearing whales. 2. Odontoceti, or toothed whales.

The first group includes the valuable right whales (*Balæna* spp.), of which *B. mysticetus*, the Greenland or Arctic right whale, is the most valuable on account of the length of the whalebone it yields. This whale has been hunted so persistently in former times that it is now rarely found, although the western race of this species, known as the bowhead, is caught frequently in the Bering Strait.

The black right whale (*B. australis*) inhabits temperate seas of both the northern and southern hemispheres. The first group of whales also includes the genus *Balænoptera*, of which there are at least four species; these are commonly called rorqual or finback whales, and now form the chief sources of whale oil, being killed off the coasts of Finmark, the Orkney and Shetland Islands, the western coasts of the British Isles, and in the Newfoundland fisheries and elsewhere. The rorqual whales are more active and dangerous than the right whales, and on this account were not hunted generally in former times; improved methods of whaling have rendered their capture comparatively safe, and large numbers are now killed. The so-called blue or sulphur-bottom whale (*Balænoptera Sibbaldi*), the largest known living mammal, belongs to this genus, and reaches a length of 80 or even 85 ft.

The second main group of the Cetacea, the Odontoceti, includes a large number of aquatic mammals differing somewhat widely in size and outward appearance. The largest and most important member of this group is the sperm whale or cachalot (*Physeter macrocephalus*), which is widely distributed in warm seas; it is easily recognised by its enormous truncated head, of curious shape, which contains a large cavity filled with "head matter" (see p. 266). Other members of this group which are killed for the sake of their oil are the bottle-nosed whale (*Hyperoödon rostratus*); the beluga or white whale (*Delphinapterus leucas*), which is found in shoals in Arctic seas and even ascends large rivers such as the Amur and Yukon (this species gives only a small yield of oil, but is valuable as the source of the so-called "porpoise-hide" leather); and the

grindwal, black fish, or pilot whale (*Globicephalus melas*), a small whale known also as the ca'ing (driving) whale on account of the ease with which it can be frightened and driven ashore. The orca, grampus, or killer (*Orca gladiator*) also belongs to this group.

The porpoises (*Phocæna* spp.) and dolphins (*Delphinus* spp.) are also used as sources of oil.

Whaling

The introduction about 1865 of gun harpoons by Svend Foyn rendered it possible to kill whales from the vessel instead of having to approach them in small rowing boats, a method which was too hazardous to be employed with rorqual whales. Formerly the carcase of the whale was slung alongside the ship, the blubber was stripped and boiled on board, the whalebone was removed, and finally the carcase was discarded. Such methods as these are still employed in certain whale fisheries remote from land, but the method generally practised at the present time is to use the whaling vessel merely for the capture of the whales, which are then brought to land and worked up for oil, the flesh and bones being converted into manure.

The whales are sighted from the whaler by the lookout near the masthead, and are then approached until they are well within range, when the harpoon is fired. The latter is a missile about 5 ft. long, weighing over a hundred pounds; the point is composed of a bomb containing an explosive charge, and the shaft to which the bomb is screwed bears barbs which expand and so prevent the harpoon from pulling out. The gun used for firing the harpoon is mounted on the bow of the steamer, a strong hemp rope several hundred fathoms long being attached to the harpoon. When struck by the harpoon the whale "sounds" or blows and dives, and if not seriously injured, may live for a considerable time. Finally, when the whale on coming to the surface blows blood, it is approached and lanced to death. Although this method of capturing whales by explosive harpoons from the whaling vessel is much less dangerous than the older method with rowing boats, disasters sometimes occur, a motor schooner of about

fifty tons being sunk by a harpooned whale off Alaska in 1910.

Preparation of Whale Oil

On reaching the shore station the whale is hauled on to a "slip" and the blubber removed by making longitudinal cuts from head to tail, the strips of blubber being pulled off by a hook and wire rope attached to a steam winch. The strips are then put through a blubber-cutting machine which cuts them into thin slices which are carried by bucket conveyors to steam-heated vats, where the oil is boiled out. The oil is separated and the residue of blubber, after being drained free from water, is taken to hot-air driers, mixed with the flesh residue and converted into manure.

After removing the blubber, the flesh is taken from the skeleton, and is generally boiled for oil, the residue being dried for use as manure. The bones are also dried, ground, and sold for use as bone manure. In some countries, for example Japan, large quantities of whale flesh are used for human consumption. The meat is stated to be quite palatable and to resemble beef, and an Alaska whaling company is reported to be experimenting with its use for the preparation of meat extract (*The Fisheries of Alaska in* 1908*: U.S. Bureau of Fisheries, Document* 645, p. 71), but no information as to the results of these experiments is available.

In the following table are given figures showing the approximate yields of oil obtained from the different kinds of whales (*Report of Commissioner for* 1902, *U.S. Commission of Fish and Fisheries*, p. 192):

Species of whale.	Oil barrels (31½ gallons).		
	Minimum.	Maximum.	Average.
Right whale, Pacific	25	250	90
Right whale, Atlantic	25	150	75
Bowhead whale	30	250	100
Sperm whale	5	145	45
Humpback whale, Pacific	10	110	42
Humpback whale, Atlantic	10	100	40
Finback whale, Pacific	10	70	35
Finback whale, Atlantic	20	60	38
Californian grey whale	15	60	30
Bottlenose whale	4	25	12
Orca or killer whale	1	6	2½
Beluga or white whale	⅜	3	1⅛
Blackfish or grindwal	⅛	4	1⅛

Properties and Uses of Whale Oil

With the exception of the "head matter" of the sperm whale (see below), the oil obtained from the various species of whale is mixed and sold under the name of "whale oil," though "humpback oil" appears to be kept separate sometimes. "Train oil," formerly the name of northern whale oil, is now applied to all kinds of whale oil and even fish oils.

A number of grades of whale oil appear on the market, differing in character according to the methods of preparation and also from the fact that oil is obtained from the flesh as well as from the blubber. The oils vary in colour from water white to dark brown, the darker oils having a pronounced fishy smell. The following figures were obtained by Bull (see Lewkowitsch, *Chemical Technology and Analysis of Oils, Fats, and Waxes*, 1909, ii., 379) from the examination of a number of different grades of whale oil.

Specific gravity at $\frac{15^\circ C.}{15^\circ C.}$		0·916–0·927
Acid value		0·56–98·5
Saponification value		178·3–188·6
Iodine value	*per cent.*	89–136
Unsaponifiable matter	*per cent.*	1·37–3·3

The lighter coloured grades of whale oil are used as illuminating oil and in soap making. The lower grades are employed in leather dressing, jute batching, for tempering steel, and also for lubricating. The use of whale oil for edible purposes may in the near future be rendered possible by the "hydrogenation process."

Sperm Oil and Spermaceti

The sperm whale differs from most other species of whale in containing a large quantity of oily matter called "head matter" in the head cavity. This is liquid at the temperature of the live animal and is baled out, and kept apart from the blubber oil. On cooling it solidifies, and is separated by freezing and pressing into solid spermaceti and liquid sperm oil. The bottlenose whale also yields a similar head oil.

Sperm oil and spermaceti differ from other whale oils, and are classed by Lewkowitsch as waxes. Spermaceti consists almost entirely of cetyl palmitate, and is a lustrous, white, crystalline solid, which is brittle, and with care can be rubbed to powder; it melts at from 41° to 46° C., and has the following constants (Lewkowitsch, *loc. cit.* p. 780):

Specific gravity at $\frac{15°\text{ C.}}{15°\text{ C.}}$	0·960
Saponification value	120·6–134·6
Iodine value *per cent.*	3·8
Unsaponifiable matter, consisting principally of alcohol *per cent.*	51·5–54·2

Spermaceti is used in the manufacture of sperm candles and certain pharmaceutical and toilet preparations.

Sperm oil is a pale yellow, thin, almost odourless oil of unknown chemical composition, differing from whale oil in having lower specific gravity, saponification value, and iodine value as is shown by the following figures (Lewkowitsch, *loc. cit.* p. 730):

Specific gravity at $\frac{15°\text{ C.}}{15°\text{ C.}}$	0·844–0·883
Saponification value	120–147
Iodine value *per cent.*	81·3–90·1
Unsaponifiable matter (wax alcohols) *per cent.*	39·0–44·3

Sperm oil is a particularly valuable lubricant, as it does not readily thicken or become sticky, and can be used, therefore, for delicate machinery; a further advantage is the fact that the viscosity does not decrease with increased temperature so rapidly as does that of other lubricating oils.

Statistics of Whaling

Reliable data as to the extent of the modern whaling industry are difficult to obtain. In the following paragraphs a few details as to the most productive whaling areas at the present time are given. The whaling industry appears to be largely carried on by Norwegians, and whaling expeditions are sent by Norwegian companies to whaling areas all over the world. Whaling has been carried on during recent years around the coasts of Newfoundland, the greater number of the whales killed being

finbacks. Thus in 1912 289 whales were killed, of which 202 were finbacks, 60 sulphur-bottom whales, 22 humpbacks, and only 5 sperm whales. The following numbers of whales and amounts of whale oil were obtained in recent years (*Ann. Rept.* 1912, *Dept. Marine and Fisheries, Newfoundland*, p. 32):

	1910.	1911.	1912.
Number of whales . .	384	335	289
Oil, gallons . . .	416,831	405,644	400,552

There are four stations on the coast of British Columbia, where whaling has been carried on very successfully during recent years, 1,107 whales being landed during 1912-13. Several species of whale are found, the commonest being the sulphur-bottom whales; humpback and finback whales are also obtained, while in 1912-13 19 sperm whales were captured; occasionally right whales are obtained. The amount of whale oil marketed in British Columbia in 1912–13 was 1,369,096 gallons, valued at £95,498.

A whaling station is in operation at Seven Islands, in the Gulf of St. Lawrence, Quebec, 90 whales being taken during the year 1912–13, including one right whale. In that year 149,310 gallons of whale oil, valued at £9,207, were marketed, as well as 11 tons of whalebone, valued at £1,018.

The total exports of whale oil from Canada in 1912 amounted to 2,422,845 gallons, valued at £203,128, and in 1913 1,618,327 gallons, valued at £109,437.

The only shore whaling station in the United States where all the parts of the whale are utilised is at Tyee, South-east Alaska, although a number of stations exist along the Arctic shores of Alaska for the purpose of trading in the whalebone obtained from whales hunted by Eskimos. The amount of whale oil produced in Alaska was 369,930 gallons, valued at £24,431 in 1910, and 250,200 gallons, valued at £18,244 in 1911. In the former year 512 cwts. of whalebone, valued at £2,055, were produced, and in 1911 516 cwts., valued at £2,607.

In the South Atlantic whaling is carried on round the Falkland Islands, and eight companies were established during 1911 in the island of South Georgia, a dependency

of the Falkland Islands, while ten companies held licences for the South Shetlands and Graham's Land. The total value of products of the industry in the South Atlantic (Falkland Islands, South Georgia, South Orkneys, South Shetlands, and Graham's Land) amounted in 1911 to £1,026,415.

A whaling station has also been established at Durban, Natal; in 1912 984 whales were landed, 6,666 tons of oil, 2,900 tons of manure, and 50 tons of "finner" whalebone were produced, valued at £110,000. A whaling station is also situated at Saldanha Bay, Cape Province.

According to the *Board of Trade Journal* (1914, **84**, 264) there were 13 whaling companies working on the West Coast of Africa in 1913, as compared with 8 in the previous year; their output of oil was approximately 149,500 barrels. There were 41 small steam whalers employed between Cape Lopez and Great Fish Bay, and it is estimated that 6,350 whales were killed in 1913, as compared with 4,250 in the previous year.

In the North Atlantic and Arctic seas the principal whaling grounds are around the Faroë Islands, Iceland, and the coast of Norway, off the coasts of the Shetlands and Hebrides, and the west coast of Ireland.

Whaling is also carried on in the seas near Japan, Argentina, the Azores, and Chile.

It is difficult to estimate the amount of whale oil imported into the United Kingdom, as the returns include under one head—"Fish oils"—train, blubber, sperm, etc., oils, the following being the quantities and values imported recently:

Fish Oil, viz. Train, Blubber, Sperm, or Head Matter

	1910.	1911.	1912.
Quantity, tons	46,101	58,962	68,030
Value, £	927,231	1,252,663	1,296,477

Of the above quantity in 1912, 33,718 tons were derived from British possessions, as follows:

	Tons.	£.
Falkland Islands	10,064	167,435
Newfoundland	4,406	92,285
Natal	8,829	167,919
Canada	6,900	153,108
Other British Possessions	3,519	80,013

Other Whale Products

Apart from the whale oils already referred to, two other important and interesting products are obtained from whales, viz. whalebone and ambergris, to which reference may be made, although they do not fall strictly within the scope of this article.

Whalebone

This is the name commonly given to the baleen or plates of hornlike, lamellated material attached to the upper jaw of whales belonging to the genera *Balæna* and *Balænoptera*. The baleen plates fit into deep grooves when the mouth of the whale is closed, but they spring forward when the mouth is opened and entirely fill the space between the jaws, serving as a sieve to collect the minute organisms on which these whales feed. The number of plates amounts to as many as 360 on each side of the jaw. The baleen differs in length, formation, and quality according to the species of whale. The best is now obtained from the arctic bowhead whale and measures up to 10 ft. or more in length and 10 in. to 12 in. wide at the butt where it is fixed in the jaw. The plates taper gradually from the butt and bear a coarse, short, hairlike fringe. The bowhead whale yields more baleen than other species, one which yields 100 barrels of oil (see p. 265) yielding from 1,500–2,000 lb. of baleen; the right whales come next in yield; while the finback whales only yield a small amount (about 250 lb.) of coarse baleen, about 4 ft. in length, of inferior quality, and only worth a fraction of the value of that derived from bowhead or right whales. The relative values of the commercial grades of whalebone per ton in the London market are as follows:

"Davis Straits" and "Arctic," £650–750.
"Southern," £400–600.
"Finners," £15–30.

Owing to the irregularity of supply and to other causes, whalebone has been and is now subject to extreme fluctuations in value; for example, the value of "Arctic" whalebone was £1,100–1,400 per ton as recently as 1912.

The baleen is taken from the whale by cutting out 3 or 6 plates with the gum adhering, and is carefully stored until opportunity occurs on the homeward voyage for it to be cut out from the gum and washed. The plates are then put up in bundles of about 22, weighing about 80 lb.; this is sometimes done on board ship, but generally on shore. The tools and appliances for working the whalebone are simple, and consist of tanks and steam boxes for soaking and steaming the bone to soften it, together with special draw-knives, cutting and scraping knives and splitting machines; but considerable skill and knowledge on the part of the workmen are necessary. Details of the methods of working and of the different grades and classes of bone into which the raw whalebone is separated are given in *Document* No. 626, *U.S. Bureau of Fisheries.*

The imports of whalebone to the United Kingdom in 1911 amounted to 11,210 cwts., valued at £76,207. Of this quantity 3,132 cwts. came from Canada, 297 cwts. from Newfoundland and the Labrador coast, and 3,408 cwts. from other British possessions; the remainder from foreign countries.

Although numerous substitutes for whalebone, such as steel, rattan cane, horn, quills, celluloid, etc., have been tried and have replaced it for some uses to a large extent, the unique properties of whalebone, such as its lightness combined with great elasticity, render it almost indispensable for certain purposes. At the present time it is chiefly used in the dress, corset, and brush making trades.

Ambergris

This material is a greyish wax-like substance, hence its name *ambergris*, known from early times and once reputed to possess remarkable medicinal and other properties. The product was found sometimes in large quantities on the shores of the Indian and Pacific Oceans, and its origin was at one time the subject of much speculation. It is known now to be a product of the sperm whale of either sex. Its formation appears to be due to a diseased state of the whale (possibly of a biliary nature), as the whales in which it is found are always in poor condition

and sometimes emaciated. The ambergris may be ejected by the whale, or may be found in the intestinal canal, generally near the ventral aperture. The whalers always seek for it by probing with a cutting spade, its presence being detected by the peculiar feeling produced when it is cut by the spade. It occurs in lumps varying in weight from under 1 lb. to 150 lb. or more; it generally contains pieces of the beaks of the cuttlefish on which the sperm whales feed. On removal from the whale it is soft and possesses an offensive smell, but on exposure to air it hardens, loses its unpleasant odour, and develops its characteristic heavy aroma. Enormous quantities have occasionally been found: a mass said to weigh 600 lb. was brought home by an American whaling boat from the Bahamas in 1858, but perhaps the largest find recently disposed of was obtained in the Azores, in 1898, which weighed 274 lb. and was sold in small lots in London (*Perf. and Essential Oil Record*, 1911, **2**, 253). Ambergris has been used for centuries in ecclesiastical rites, and as a medicine and perfume especially in Asia and Africa. Its only use at the present time is in the manufacture of perfumes. Although it is not itself possessed of a strong or very pleasing odour, it has the power of "fixing" other scents. Nothing appears to be known about the chemical composition of this interesting product. As one would expect from its source, the supplies of ambergris are very irregular, and the price varies widely.

Seal Oils

The different kinds of seals (*Phocidæ*) and sea-lions (*Otaridæ*) which are killed for the sake of the hides or fur skins which they bear (see this BULLETIN, 1908, **6**, 300), also yield considerable quantities of oil from the layer of blubber under the hide. In the seals this blubber is from 1 to 3 in. in thickness, and the oil is prepared by methods similar to those employed for the manufacture of whale and fish oils. The older process of allowing the oil to exude spontaneously from the blubber as it gradually decomposes is now replaced largely by steam-boiling as in the case of whale and fish oil manufacture. Seal oil

varies somewhat in character according to the species of seal from which it is derived, but in the main resembles whale oil, although the iodine value appears to be generally higher.

The following figures are quoted (Lewkowitsch, *loc. cit.* p. 372) for oils derived from *Phoca grœnlandica*:

Specific gravity at $\frac{15°\ C.}{15°\ C.}$	. . .	0·924–0·929
Saponification value	. . .	178–196
Iodine value	. . . *per cent.*	127–162

The oil is often mixed with whale oil and is used for similar purposes; 2,778 tons of seal oil, valued at £60,951, were exported from Newfoundland in 1911–12.

FUR-FARMING IN CANADA

Owing to the increasing scarcity and high prices of furs during recent years, attempts have been made in Canada to breed some of the more valuable fur-bearing animals in captivity, and the progress and possibilities in this direction are discussed in a report by J. W. Jones, B.S.A., recently published under the above title by the Committee on Fisheries, Game, and Fur-bearing Animals, of the Canadian Commission of Conservation.

Enquiries made in the latter part of 1912 showed that foxes of two species and various colour varieties, skunk, mink, raccoon, fisher, beaver, and muskrat, were all being experimented with on fur-farms, while attempts were also being made to domesticate the marten and otter. Up to the present most of the work on fur-farming has been done in the Maritime Provinces, but it is developing rapidly in Ontario and Quebec, and isolated fur-farms exist throughout the Western Provinces.

The most important work accomplished so far is that of rearing foxes in captivity, attention being paid chiefly to the dark or so-called silver foxes on account of the great value of the skins.

Silver-Fox Ranching.—Attempts have been made for a number of years past to rear valuable black or silver foxes

in captivity, but the experiments of Dalton and Oulton on Prince Edward Island are chiefly responsible for the establishment of this industry on its present successful commercial basis. There were in 1912 200 fox ranches on Prince Edward Island, owning 650 silver foxes and also a number of less valuable cross-bred and red foxes. The estimated total number of foxes in Canada in 1912 was as follows: silver 800, cross 250, bastard and red, 1,450; the total number of ranches in that year was estimated at 241. The method of fox ranching may be briefly described as follows:

The foxes are kept in separate pens measuring about 25 ft. by 50 ft., constructed of strong wire netting 10 ft. to 15 ft. in height. As the foxes are powerful diggers it is necessary to place a carpet wire several feet in width inside the fence, and also to sink the wire fences about 4 ft. in the ground, or at any rate down to the level of the "hard-pan" when this exists. As the foxes are also good climbers, an overhanging strip of wire is necessary at the top, or this may be obviated by using plain sheet iron for the upper part of the fences; the latter is specially advantageous as the foxes cannot climb it and are consequently free from any chance of damage due to falls.

Several pens are placed together and surrounded at some distance by a fence, 10 ft. to 15 ft. high, the objects of which are to prevent escape of foxes which may get out of the pens, and to keep animals and strangers away from them. The outer fences are composed of wire-netting, or of boards 6 ft. to 10 ft. high, with 4 ft. of wire netting at the top. In either case a strip of overhanging netting is fixed to the top, and a carpet wire 3 ft. wide placed on the ground inside the fence.

The most suitable locality for the ranch is a well-drained, wooded site, as this keeps at an equable temperature throughout the year, and is less liable to snowdrifts, while the trees form excellent cover for the shy foxes.

The foxes are provided with wooden kennels which are carefully constructed inside so that no rough projections exist which can damage the fur; part of the kennel is constructed as a small nest carefully insulated so that the

female can keep the young warm. Mating takes place early in the year, and the young are born about fifty days later; after mating the male is generally separated. Great care is necessary during the breeding season, and after the young are born, to prevent the animals being alarmed. So great is the danger that laws have been enacted in New Brunswick and Quebec imposing heavy fines for trespass on the ranches. A litter consists of one to nine pups, which can be separated from the mother when three months old. The young foxes generally mate when ten months old and continue prolific for ten or eleven years. Food of a very varied nature is fed to the foxes; meat of all kinds, fish, milk, and corn-meal being among the principal foods used, while dog biscuits are also useful. So far no serious diseases have occurred on the ranches.

The fur becomes prime in November, but is heavier in December, and the foxes are killed at the end of the latter month. Some owners kill the foxes at eight months of age, when they are said to yield fur as good as that of older foxes; other owners prefer to kill when twenty months old. Killing is effected by breaking the neck or by crushing the chest; but the use of chloroform or other poison is more humane and cannot damage the fur, and is to be recommended. The skinning of the fox must be carried out with extreme care. Incisions are made on the inside of the hind legs, and the whole of the skin of the body is stripped off without cutting. The skins are then stretched on a board, flesh side out, and all fat, etc., removed. The skin is allowed to dry for one day and is then turned fur side outwards. Finally it is stretched over a board and allowed to dry thoroughly. When dry the pelts are sewn in muslin and carefully packed.

A point of great importance which has been discovered in silver fox breeding is that by mating a pure black (or silver) fox with a pure red fox, litters of cubs can be obtained in two generations, half the number of which are pure silver and the other half red.

Up to the present time the majority of the silver foxes bred have been sold for breeding purposes and have fetched very high prices, $20,000 (about £4,000) being recorded for

one pair in 1912. A fair number of skins of ranch-bred foxes have been sold and have fetched high prices; at present the record price is £580 paid for a single skin on the London market, while half a dozen skins have sold at £500 or more apiece. The average price for silver fox skins sold in London in 1911 was about £60. This includes wild and ranch-bred skins. The reasons for the high prices paid for silver fox skins are the durability and beauty of the skins; fine-grade skins are composed of bluish-black heavy fur with silvery hairs evenly distributed over the pelt.

The fox-breeding industry is at present in a very speculative condition, but there seems little doubt that it should prove very remunerative if carried out on a fair scale under intelligent management. Full details as to management, food, etc., are given in the work quoted.

Polar or Arctic Fox (*Vulpes lagopus*).—These are much less valuable than the silver fox, but the blue Arctic fox skins are worth about $30, and fine skins may fetch as much as $75 or more. A considerable number of blue foxes were imported into Canada in 1912, but so far no information is available as to the results of the experiments in breeding these animals in the Dominion. Blue fox farming has, however, been carried on for some years past in several small islands off the coast of Alaska. At present most of the attempts to breed this fox appear to have taken the form not of ranching but of allowing the foxes to roam in their natural habitat, and of improving the conditions of their life by feeding during periods of scarcity. On the island of St. George (Pribiloff Islands, Alaska) systematic feeding of the foxes since 1896 has been pursued. For this purpose the carcases of seals have been salted down and fed to the foxes during the winter; other food has also been used when seal-meat is not available. The management of the fox industry in St. George is under the control of a Government Agent, who decides which animals are to be killed or released for breeding. The foxes are caught readily in pens or traps baited with food. White foxes have been exterminated on the island as far as possible, as the skins are of comparatively little value. In 1907–1908,

446 foxes were killed and about 270 pairs released for breeding, and it is stated that the numbers could be indefinitely increased. The exploitation of blue foxes on a similar plan on small islands where food is easily obtainable should prove successful.

Raccoon (*Procyon lotor*).—So far this animal does not seem to have been reared in captivity, but it is likely that this could be done successfully in the northern districts of Canada.

Mink (*Putorius vison*).—Mink farming is still in the experimental stage, but it has been shown that the animal can be reared successfully in captivity. Various systems are being tried, and a French Company on Lac Chaud, Quebec, has enclosed an area on the shore where the mink live under natural conditions; this seems likely to prove successful. They can also be kept in colonies of families, or in separate pens.

Marten or American Sable (*Mustela americana*).—Although very savage, it seems likely that these can be bred in captivity, and attempts are being made by Canadian fur farmers to obtain marten for breeding.

Fisher or Pennant Marten (*Mustela Pennanti*).—Only two ranches were found by Mr. Jones where fishers were kept. In one case the experiment seemed fairly successful, although no young had yet been produced, and it is likely that interest will be taken in the fisher, as first-class skins were worth $75 to $100 in 1912.

Canadian Otter (*Lutra canadensis*).—Canadian otter skins are said to be superior to those of otters from other localities, and were quoted at $20 to $25 each, if of dark colour, in January 1913 Otters have been kept successfully in many zoological gardens, but have not bred; if they can be bred in captivity the industry should prove profitable, as they are easy to keep.

Skunk (*Mephitis mephitica*).—In common with other skins, skunk skins have increased in value recently, No. 1 northern skunk fetching $4·25 in 1912, and if the price continues to rise skunk farming should become a profitable undertaking if carried on on a large scale. So far, however, skunks have been bred only on a small scale.

Muskrat (*Fiber zibethicus*).—The skins of this small animal are not very valuable, but the species breeds freely, and can be reared in large numbers on protected marshes; the fur, musk bags, and flesh are all readily saleable.

Beaver (*Castor canadensis*).—Owing to persistent trapping in the past the beaver is in danger of becoming extinct in Canada, as it has done in most parts of Europe. It cannot be farmed, as it requires large areas to furnish food; the only plan is to encourage the beavers to multiply by protection in large game preserves under constant patrol. In the Algonquin National Park, Ontario, beavers yield a large revenue yearly.

TIN RESOURCES OF MALAYA AND INDIA

TIN has always been to a large extent a British product. In the time of the Phœnicians, and long after, Cornwall appears to have furnished the greater part of the world's supply of the metal, and to-day more than half of the total output is produced within the British Empire. This is shown by the following table, which gives the world's output of tin for 1911, the last year for which complete figures are available.

British Empire.	*Long tons.*
Malay States	44,136
Australia	6,888
United Kingdom	4,870
Union of South Africa	2,308
Nigeria	2,157
India	138
	60,497
Total British Empire	60,497
,, Foreign Countries	54,051
	114,548

Foreign Countries.	*Long tons.*
Bolivia	21,887
Dutch East Indies	19,909
China	5,958
Siam	5,928
Japan	144
United States	60
Portugal	50
Indo-China	40
German Empire	35
Austria-Hungary	19
Spain	15
Italy	6
	54,051

In the present article it is proposed to describe the tin fields of the Malay Peninsula and India, while the Australian and African occurrences will be dealt with in a later number of this BULLETIN.

The Malay Peninsula

I. *General*

The sequence of rocks in the Malay Peninsula, as described by Mr. J. B. Scrivenor, the Government Geologist, is indicated in the following table:

Sedimentary	*Igneous*
Recent alluvium, lignite, torrential deposits, etc.	
Tertiary coal measures of Selangor.	Dolerite dykes cutting Mesozoic granite.
	Mesozoic granite, stanniferous.
(*Unconformity*)	
Gondwana Rocks — conglomerates, quartzites, shales, and slates; stanniferous boulder clay (Gopeng Beds).	Pahang Volcanic Series—quartz-porphyry, porphyry, granophyre, dacite, andesite, augite-andesite, dolerite.
(*Unconformity*)	
Raub Series — limestones and calcareous shales; radiolarian chert.	
	Palæozoic granite—stanniferous; not known *in situ*.

The Main Range, which forms the principal watershed of the Peninsula and the dividing line between Perak and Selangor on the west and Kelantan and Pahang on the east, is formed of granite, which appears to have been intruded later than the Triassic period and before the Eocene. Offshoots of this granitic axis form hills in Province Wellesley and Penang, to the east of the Larut district, in the Dindings, and in the Kledang Range, between the Perak and Kinta rivers. On the western side of the Peninsula there are also quartzite hills such as the Semanggol Range in Perak, the hills near Telok Anson, and those which occupy a large part of Selangor, as well as limestone hills with precipitous sides, which are well developed in the Kinta district of Perak.

Immediately to the east of the Main Range, in Pahang, is a chain of foothills composed of quartzite, conglomerate, and shale. Farther east lies the Benom Range, formed of granite which is for the most part hornblendic, and beyond that is a belt of hilly country where the Gondwana rocks attain their greatest development.

By far the greater part of the Malay tin comes from

what are generally classed as alluvial deposits, lode mining furnishing a comparatively small proportion. But the so-called alluvial deposits differ greatly among themselves in character, in origin, and in age. Among the granite hills, for example, many of the valleys are full of huge boulders of resistant granite from which the decomposed matrix has been washed away. These "core-boulders" act as natural riffles, and Chinese miners burrow beneath them in search of the rich pay-dirt. For this they sometimes pay with their lives, through the collapse of the unstable mass of boulders.

In the limestone hills, again, tin-bearing gravel, sand, and silt have been washed into caves and fissures, which may now be high above stream-level. Here they have become stained with iron oxide, and sometimes cemented with calcite, requiring to be crushed before the cassiterite (tinstone) can be recovered.

An important series of clays with angular tin ore, and sometimes containing boulders, is now known to be a glacial deposit of Gondwana age (Permo-Carboniferous). These are the Gopeng Beds of the western states.

The lodes that are worked for tin include veins, pockets, stockworks, and impregnations in granite, shale, sandstone, and limestone. In many cases the granite or pegmatite is so decomposed as to be readily worked by pick and shovel, or even by the jet of water from a monitor.

Various methods are employed for winning the cassiterite from the alluvial deposits and soft igneous and sedimentary rocks. On small patches of alluvium many Chinese mines consist of a simple *lampan* or ground sluice into which the pay-dirt (*karang*) is hoed from the adjacent hillside. On larger properties a *lumbong* or opencast mine is opened, from which the *karang* is carried in baskets to the sluice boxes. Mining by shafts and galleries is sometimes adopted. In some cases, after the richest ground has been extracted in this way by Chinese miners, the property may still yield good profits if worked by hydraulic monitors. Recently gravel-pump dredges of Australian design have been successfully employed on low-grade properties in the Kinta district.

Associated with detrital tin ore in the crude concentrates, there are other heavy minerals which are separated from the cassiterite by careful washing. The rejected portion, known as *amang*, may be treated by an electro-magnetic process to recover what cassiterite remains in it, as well as other minerals of value, such as wolframite and monazite. Other minerals occurring in the *amang* are ilmenite, magnetite, zircon, rutile, garnet, tourmaline, topaz, corundum, xenotime, andalusite, tremolite, hæmatite, limonite, pyrite, arsenopyrite, chalybite, anatase, brookite, scheelite, galena, native copper, columbite, and strüverite. Several samples of *amangs*, and of minerals isolated from them, have been examined at the Imperial Institute (see this BULLETIN 1906, **4**, 301; 1908, **6**, 155; 1911, **9**, 354; and 1913, **11**, 243).

The Federated Malay States, and particularly Perak and Selangor, produce all but a trifling proportion of the tin output of the Peninsula. The relative importance of the different States as tin producers is shown in the following tables:

	Tin exported in 1912.	
	Quantity.[1] *Long tons.*	Value. £.
Perak	28,407	5,757,793
Selangor	15,202	3,079,388
Negri Sembilan	1,730	349,769
Pahang	2,663	628,597
Total for Federated Malay States	48,002	9,815,547

[1] *Weight of tin exported as metal or in ore (calculated at 70 per cent. of the gross weight of the ore).*

	Tin ore exported in 1912.	
	Quantity.[1] *Long tons.*	Value. £.
Kedah	835	111,339
Perlis	188	(No returns)
Kelantan	19	2,710
Trengganu	403	56,607
Total for Protected Malay States	1,445	...

[1] *Gross weight of ore.*

Large quantities of metallic tin are exported from the Straits Settlements, being smelted therein from ores produced in the Federated Malay States. No tin ore is produced in Singapore or Penang, but Malacca produced

11 tons in 1912. A small amount is obtained in the State of Johore, but no statistics are available.

II. *Perak*

The geology of the Kinta district, Perak, was summarised in this BULLETIN (1913, **11**, 537). Crystalline limestone underlies the wide valley through which the Kinta river flows. It is covered in part by clays and boulder clays (Gopeng Beds) of Gondwana age. The younger Gondwana rocks are mostly shales and quartzites. Fault-blocks of the limestone form precipitous hills rising above these younger beds. The valley is flanked by the granite of the Main Range on the east, and of the Kledang Range on the west. The intrusion of this granite, which is evidently younger than the Gondwana rocks, was accompanied by pneumatolitic action and the formation of tin-bearing veins. But the boulder clays contain detrital cassiterite which cannot be derived from the Mesozoic granites of the Main and Kledang ranges, but must be attributed to some earlier stanniferous intrusion. Boulders of tourmaline-corundum rock occur in these beds. The recent deposits include sand with seams of lignite and stanniferous alluvium and cave deposits. Even the soil is stanniferous, especially where the Gopeng Beds outcrop.

The principal mining areas in the Kinta District are as follows, beginning in the south-east, proceeding northward along the east side of the valley, and returning southward along the west side:

Kampar.—In this district the old Gondwana clays overlying limestone are worked in the low-lying country, while shallow alluvial deposits on the granite slopes of Bujang Malaka have also yielded ore. In the Ulu of the Petai a pipe containing felspar, tourmaline, cassiterite, and metallic sulphides was found in a tourmaline-felspar country rock. The pipe was at first only slightly inclined to the horizontal, and measured about 8 ft. by 13 ft. The ore is said to have yielded 5 per cent. black tin, and about 1,000 pikuls were won from it (1 pikul = 133·3 lb.). The apparent absence of quartz and the freshness of the felspar are peculiar features of this occurrence.

Malim Nawar.—Here sandy soil resting on limestone is washed for cassiterite. It appears to be the coarser residue of Gondwana clays.

Sungei Siput.—This village is situated on the Depang river south of the limestone mass of Gunong Tempurong. In Jehosaphat's (Jesophat's) Valley an old fault-fissure, trending N.N.W. and S.S.E., has become filled with detrital quartz, tourmaline, iron ores, topaz and cassiterite, which were subsequently cemented with iron-stained calcite to form a rich "vein" about 4 ft. wide. A large cave in the neighbourhood is also known to contain detrital tin ore.

Gopeng.—This area includes the Gopeng, New Gopeng, Ulu Gopeng, Kinta Tin, Tekka, and Sungei Raia mines. On many of these properties hydraulic operations on a large scale are carried on, the monitors removing both clays and boulder clays and decomposed granite. Interesting sections of these rocks and the veins that traverse them are thus exposed.

Pulai.—Most of the tin ore of this field has been obtained from the glacial deposits, though it also occurs in the granite and in caves in the limestone. At the Kramat Pulai mine the junction of boulder clay and granite, with a kaolin vein in the former, was recently exposed.

Ulu Piah.—This mine is situated near Ampang on a patch of the glacial beds faulted down between the granite and the limestone.

Tambun.—In both the Tambun and New Tambun mines the glacial clays, which are practically free from boulders, are cut by hand and puddled to separate the tin ore.

Tanjong Rambutan.—Here, not far from the northern boundary of the Kinta district, there are two mines—the Rambutan and the Kinta Association. In the latter the glacial clays are remarkable for the number of large quartz boulders they contain.

Menglembu.—On the west side of the Kinta valley, near Menglembu village, a number of ore-bodies have been found in the granite of the Kledang Range. Some of these ore-bodies are ordinary veins, while others may be described as pipes. To the former class belongs

the lode on Bukit Kambing, which trends N.E. and S.W., and has a dip of 32° from the vertical. The width of the portion worked was 4 ft., and the average yield of ore 6 per cent. Work was abandoned when the yield fell to about 2 per cent. black tin. Several other lodes are known; they have a similar strike to the Bukit Kambing lode, and like it are associated with fairly fresh felspar and much tourmaline. Fluorspar is sometimes present.

The pipe-like mode of occurrence is seen in the workings of the Menglembu Lode Syndicate. Here the granite is strongly jointed and contains in places numerous minute veins of cassiterite set close together. Their direction is about 20° E. of N., cutting the joints at an angle of about 45°. The little veins form ore-bodies which, though very irregular, average about 60 ft. by 20 ft. in horizontal dimensions, while one of them has been followed down for 500 ft.

Penkalan.—Three large excavations are worked to the north of Lahat. They are all in the Gondwana clays. In No. 2 a fault with a throw of about 20 ft. has been exposed in the limestone floor, while in No. 3 small bodies of ore occur in the limestone itself, and the remains of others on its irregular surface.

Lahat.—In this great opencast mine, stiff blue clays of Gondwana age overlie stanniferous granite which rises to the west, and are themselves covered by beds of sand and clay with seams of lignite. These recent deposits are a more important source of tin ore than the Gondwana clays themselves.

Rotan Dahan.—Here angular tin ore is distributed throughout a series of clays, 140 ft. thick in places.

Redhills and Pusing Lama.—Both these mines are in red clays and boulder clays with abundant boulders of tourmaline-corundum rock, and in both tin-bearing veins have been found in addition to the detrital tin ore.

Pusing Bharu.—Here also the tourmaline-corundum rock is abundant in the boulder clays. These are covered by stanniferous sandy beds and lignite. The

limestone floor, by solution, gives rise to well-marked "cups," which are lined with Gondwana boulder clays and filled with sand and lignite.

Siputeh.—Here the cups are even better developed, and caused great trouble when the mine was first opened. The rare occurrence of a tourmaline vein in the limestone has been noticed here.

Tronoh. — A large opencast mine was formerly worked by a system of shafts and galleries in the so-called "Tronoh deep-lead." This is really a huge trough or elongated cup in the limestone, filled with Gondwana clays below and sands and lignite above. The western boundary is a reversed fault which brings down the younger Gondwana rocks, quartzites and shales with granite intrusions.

Tanjong Toh Allang.—The country here consists of quartzites, shales, and tourmaline schists, but there is some evidence that the older Gondwana glacial beds occur below. The most prosperous mines are in the vicinity of kaolinised granite intrusions.

Tin Ore in Limestone.—The deposits of non-detrital cassiterite in limestone may conveniently be described together. They occur in the form of veins and pipes, the latter being as a rule the more valuable. Veins have been found at Siak, near Siputeh, at Ayer Dangsang, near Lahat, where a pipe opened out into a vein in depth; and at Penkalan No. 3 mine, where several small stringers have been noted. None of these veins have proved worth following up, but in two cases they gave rise to very rich patches of ore owing to the solution of the limestone.

Pipes have been found at Lahat, Ayer Dangsang, Menglembu, and Changkat Pari. In the case of the last three the gangue is mainly calcite, though quartz occurs also, and the cassiterite is associated with pyrite, chalcopyrite, bornite, arsenopyrite, and antimonite. Fluorite and tremolite are common, but tourmaline is very rare. The Lahat pipe had a similar origin, but the calcite had been dissolved and the sulphides oxidised by descending water.

The Larut district, to the north-west of the Kinta district, is another important tin area. The country round Taiping is an alluvial flat, rich in cassiterite, which is bounded on the east by the granite hills of the Taiping Range, and on the west by the quartzite Semanggol Range. Lode mining has been carried on at Selama and Blanda Mabok, the lode at the latter place yielding also argentiferous galena and gold.

To the south of the Kinta district, at Bruseh, a stockwork of tin-bearing veins in schist is being worked between the Pinang and Durian rivers. The veins are numerous, and generally rich in tourmaline, and the average thickness is about an inch. A little wolframite is found. The decomposed schist is worked by monitors, the average yield being about ½ kati per cubic yard (1 kati = 1·3 lb.).

III. *Selangor*

Near Tanjong Malim, in the north of Selangor, the operations are somewhat similar to those at Bruseh. Here there are numerous veins of quartz with coarse cassiterite traversing soft sandstone and shale.

Farther south, at Serendah, decomposed granite is worked by monitors on the site of old lampans. The granite is traversed by a few veins of quartz and of a granite modification resembling greisen; these veins carry cassiterite.

Kuala Lumpur is the centre of the most important mining district in Selangor, the output of which is second only to that of the Kinta district. At Salak South a pegmatite rich in tin is worked. The Sungei Besi occurrence, like that at Tronoh, consists of unusually rich deposits occupying a great cavity at the junction of limestone and granitic rocks.

IV. *Negri Sembilan*

In the neighbourhood of Seremban decomposed pegmatite with stanniferous quartz veinlets is worked by means of monitors. In Jelebu the Triang and its tributaries yield cassiterite, and the Kuala Pilah district also contains workable deposits.

V. *Pahang*

The country to the east of the Main Range is not so rich in tin ore as that to the west. There are, however, alluvial workings near the western boundary of Pahang (Bentong, Tras, Machi), and in the Blat (Belat) valley in the Kuantan district. Lode mining is carried on near the headwaters of the Kuantan river in the north-east of the State.

The Machi tin field lies to the south of Bentong. The deposit is alluvial, and generally not more than 12 ft. in depth. The cassiterite is angular and varies so much in grain that a large proportion is lost by the crude Chinese method of dressing it. Small lodes exist in the locality. One of these was found to contain quartz, yellow garnet, cassiterite, zinc-blende, arsenopyrite, and pyroxene.

The alluvial flats at Bentong have been worked for tin, but at present the work is confined to the higher valleys of the Main Range, on the boundary of Pahang and Selangor. In these localities cost of transport is a very serious matter, all supplies and ore having to be carried by coolies for long distances over rough jungle paths. The workings are in shallow alluvium and decomposed granite. In the Chinchong valley boulders of a rock composed of quartz, topaz, and cassiterite have been found and traced to the parent rock. In the Ulu of the Kenong angular cassiterite of varying grain is won, and near Bukit Fraser stanniferous granite and pegmatite occur. On Gunong Gapis, above Tras, a soft granitic rock is sluiced for cassiterite. A small lode on the Gau stream, traversing Gondwana rocks, contains cassiterite associated with pyrite, chalcopyrite, bornite, arsenopyrite, blende, chalybite, calcite, quartz, and garnet. The Liang and Triang valleys also contain stanniferous alluvium.

There are also alluvial workings on the Blat river, a tributary of the Kuantan near its mouth.

The lodes on the Sungei Lembing, a tributary of the Kuantan, run east and west, and are from 2 to 10 ft. wide. The country rock is an altered sediment overlying granite, and the geological conditions generally resemble those of

Cornwall. The lodes carry workable amounts of copper as well as tin, especially in the upper part.

VI. *Malacca*

On the north-west coast of Malacca, for some distance south of Kuala Linggi, the sand and mud below high-tide mark have been washed for tin. The source of the mineral is a schist with numerous quartz veinlets carrying cassiterite. The schist overlies granite, and forms the shore for some distance. This schist has been mined, but most of the tin produced in Malacca has come from the beach deposits, where the material has been disintegrated and concentrated by the waves.

At Chin-Chin some tinstone has been obtained from the soil, but ferruginous cement ("laterite") interferes with hydraulic operations.

VII. *Trengganu*

In Kemaman, in the south of Trengganu, lode mining is carried on at Bundi and Sungei Ayam.

The Bundi deposit consists of soft clayey and sandy material, with masses of quartz, sulphides and iron oxides, between walls of hard granite. The length is 1,575 ft., and the greatest breadth 120 ft., and the bottom has been reached only at Glen Reef, the most northerly working. The cassiterite occurs in the soft clay and in the ironstone, in the form of slender, pale yellow needles, sometimes forming spongy masses.

The Sungei Ayam lode is from 2 to 3 ft. wide. It is very flat, and is mined by a succession of shallow stope-drives.

Sungei Sendok, Sungei Paka, and Dungun also produce some tin, and at Dungun wolframite also occurs.

VIII. *Kelantan*

Most of the tin produced in this State is obtained from a mine on a tributary of the Nenggiri, and from the Bukit Yong concession. Tin ore is known to occur in other localities, and further prospecting is likely to lead to the discovery of deposits of value.

IX. *Kedah*

There are four mining districts in Kedah, viz. Kuala Muda, Kulim, Krian, and Kubang Pasu. The greater part of the tin exported from Kuala Muda district is won in the alluvial workings near the town of Semiling, on the Merbok river, at the foot of the southern slope of Kedah Peak.

X. *Perlis*

In the State of Perlis, which lies to the north of Kedah, cassiterite is won from caves and underground streams in the limestone hills on the Setul border. The caves hitherto worked have been below water-level, and have to be pumped dry before their tin contents can be estimated. It is probable that prospecting may reveal other tin-bearing caves at a higher level, but the difficulties of transport are very great, and the conditions are not such as to attract Chinese prospectors in any number. Moreover, the cassiterite in the caves is very fine, and the detrital material in many cases is cemented by iron oxide; this necessitates crushing and the production of a large amount of slimes, with serious danger to the paddy fields in time of flood.

Glossary of the more important words connected with Malay mining and place-names

Amang, the heavy minerals associated with cassiterite or gold.
Batu, rock.
Besar, big.
Besi, iron.
Bukit, a hill.
Changkat, a hillock.
Dollar, the Malay dollar, value *2s. 4d.*
Giuting, a mountain pass.
Goa, a cave.
Gunong, a mountain.
Jeram, a rapid.
Karang, pay-dirt.
Kati, 1·3 lb.
Klian, a mine.
Kuala, a river mouth.
Lampan, a sluicing mine.
Landak, a porcupine.
Lembing, a light spear.
Lubok, a pool.
Lumbong, a hole, a mine.
Mas, gold.
Pikul, 133·3 lb. (100 katis).
Puloh, an island.
Siput, a snail.
Sungei, a river.
Tanjong, a cape.
Tujoh, seven.
Ulu, the part of a river-basin near the source.

India

The tin-producing districts of India are those of Mergui and Tavoy in South Burma. These form part of the great

tin-bearing belt which stretches from Siam through the Malay States to Banka and Billiton.

In Mergui the principal hills, which have a north and south trend, are of granite, with flanking hills of unfossiliferous schists, slates, sandstones, and quartzites. These sediments are referred to as the Mergui series; their age is unknown. Cassiterite is found under the following conditions:

1. As a constituent of decomposed pegmatite rich in tourmaline and muscovite, locally known as "Kra."

2. In massive quartz-segregations in and on the outskirts of granitic hills. Some of these segregations also carry wolframite, pyrite, and chalcopyrite.

3. In quartz veins and stringers in ground adjacent to decomposing pegmatite.

4. Hillside talus accumulations, gravel deposits, and alluvial flats. These form the deposits most usually worked.

Most of the workings are on the mainland, the chief centres being Maliwun, Karathuri, and Bokypin, but cassiterite is also known to occur in the gravels of King's, Kissering, and Davies Islands in the Mergui Archipelago.

In the Tavoy district also the alluvial deposits are washed for cassiterite, which is often associated with wolframite and sometimes with gold. The cassiterite is derived from the granite and also from quartz veins in the Mergui series.

Tin has also been produced in small amounts at Bawdwin in the Northern Shan States.

GENERAL NOTES

Mineral Survey of Ceylon.—A Mineral Survey has been conducted in Ceylon under the general supervision of the Director of the Imperial Institute since 1903. Reports on the work of the Survey are published periodically in the Miscellaneous Series of Colonial Reports, and a new number, containing reports Nos. XXVI. and XXVII., has been published in this series recently (No. 87 [Cd. 7175]). The following subjects are dealt with in these two Reports:

(1) The composition of a number of rare earth and

other minerals collected by the Survey during 1908–9, which had been the subject of special investigations at the Imperial Institute; (2) the field-work accomplished by the Survey during 1909–10, and the results of examination at the Imperial Institute of the minerals collected during that year; and (3) minerals collected during a visit of inspection paid by the Director of the Imperial Institute in 1910 to Ceylon in connection with the work of the Mineral Survey.

The results recorded illustrate again the comparatively wide distribution of thorium-bearing minerals in Ceylon and the great diversity of minerals of this type found there. Two of the concentrates examined contained 3·5 and 3·08 per cent. of thoria respectively, the thorium-bearing mineral in each case being monazite. In another concentrate both monazite and thorianite were present, the percentage of thoria being 4·82. A mineral from Kondurugala was found to contain over 36 per cent. of thoria. Other minerals of economic interest dealt with in the Reports include aluminium phosphate, chromite, molybdenite, apatite, kaolin, marcasite, and stibnite (antimony sulphide).

Mineral Production of Victoria.—According to the *Annual Report* of the Secretary for Mines in the State of Victoria, Australia, for the year 1912, the total value of the mineral output for that year was £2,331,294. This is a decrease of £132,571 on the value of the output for the preceding year. As usual, gold and coal were responsible for almost the whole of the output, these two items together contributing not less than 98·6 per cent. of the total.

The total gold output was 480,131 oz. (fine), valued at £2,039,464, a decrease of £101,391 on that for 1911. The gold treated at the Mint yielded 17,424 oz. (fine) of silver, valued at £2,200.

The total coal output was 589,143 tons, valued at the pit's mouth at £258,455 (8*s.* 9*d.* per ton), a decrease of £40,374 on the preceding year's output. Of this the State coal mine at Wonthaggi contributed 455,659 tons, valued at £184,056, the profit at this mine for the year ending June 30, 1912, being £9,833. It is estimated that there is 26½ million tons of coal available at the State mine, in seams not less than 2½ ft. thick. The introduction of coal cutters, however, has made possible the working of thinner seams, and in one place a seam 18 in. thick is being worked. The working of these thinner seams will increase substantially the total amount of coal available.

In addition to the above output of black coal, 4,012 tons of brown coal was raised, valued at £866.

Among the less important items in the output are antimony ore (£16,162), tin ore (£5,733), diatomaceous earth (£3,400), gypsum (£3,359), magnesite (£633), tungsten ore (£574), and kaolin (£342).

Mineral Production of Queensland.—In his *Annual Report* for the year 1912, the Under Secretary for Mines in Queensland gives the value of the total mineral output for that year as £4,175,355, an increase of £514,292 on that for 1911.

The output of gold was 347,946 oz. (fine), valued at £1,477,979, a decrease of £162,340 on that of the preceding year. A notable feature concerning the gold output is the fact that whereas in 1900—the year in which the gold output reached its zenith—the value of gold won from ores of the baser metals was only £5,200, the value from the same source during 1912 was £556,159.

Copper shows a large increase, the output being valued at £1,698,280 compared with £1,151,351 in 1911. Of this amount Cloncurry contributed £761,755. It is claimed for Cloncurry that this is the richest and most extensive copper field in Australia.

The tin output was valued at £364,503, an increase of £56,656 on that for 1911, due to increased activity in existing fields rather than to any fresh discoveries, though the high price of tin stimulated prospecting.

The combined output of the various coalfields again shows an increase, the total quantity of coal raised in the State being 902,166 tons, valued at £338,264. This is an increase in amount of 10,598 tons and in value of £14,266 on the 1911 output, whilst the average value of 7*s.* 6*d.* per ton was higher by 3*d.* than that for 1911.

Other notable features in the output are silver (£66,188), lead (£55,667), bismuth and wolfram (£77,082), gems (£40,016), limestone (£24,176), molybdenite (£17,349), ironstone (£9,035), opal (£3,000), and fireclay (£2,535).

The item "gems" refers to the sapphire-mining industry at Anakie, where there is a ready sale for all classes of stone, and where the advance in the prices offered for sapphires, and the advent of several new buyers, gave considerable stimulus to the industry, the output increasing in value from £24,393 in 1911 to £40,016 in 1912. This included £32,372 for gemstones and £7,644 for corundum used in other ways.

Mineral Production of Western Australia.—According to the *Report of the Department of Mines, Western Australia*, for the year 1912, the value of the total mineral output of the State for that year was £5,760,207, being £345,646 less than that for the previous year. The chief items are as follows:

	Value.	Variation as compared with 1911.
Gold	£5,448,385	− £374,690
Coal	135,857	+ 24,703
Tin	70,578	+ 15,358
Copper	60,537	− 17,581
Lead ore	22,565	+ 7,563
Silver	16,353	− 1,980

As regards gold there has been a fairly steady yearly decrease since 1903, in which year the output reached its maximum. The average value per ton of gold ore treated in the State as a whole fell from 41·19 shillings in 1911 to 39·64 shillings in 1912, and in the East Coolgardie goldfield, from which over 50 per cent. of the State's yield is obtained, the average value fell from 38·14 to 36·37 shillings per ton.

The improvement in the tin output was due to increased activity in the Greenbushes tinfield, the output in the Pilbara field being rather less than in the preceding year.

The increased output of coal is attributed to the more general use of improved machinery on the Collie coalfield, where six mines are working.

No tantalite, wolfram, asbestos, or mica was raised during the year.

The Government continues to render assistance to *bona fide* prospectors by the loan of equipment and means of transport, and the whole of the outfit is in constant use. The area held for prospecting was 9,644 acres, and though this is rather less than the area held in the preceding year, it is an indication that active prospecting is going on.

Petroleum Prospects in the Union of South Africa.—The Union Government of South Africa has issued a *Report on the Petroleum Prospects in the Union of South Africa*, by E. H. C. Craig (Pretoria: Government Printing and Stationery Office, 1914). In his introduction Mr. Craig deals with various fallacies concerning the indications of petroleum occurrence. Of these perhaps the most familiar is the confusion by some people of films of iron oxide on water with oil films, an error made very frequently by inexperienced or badly-trained prospectors. More excusable, perhaps, is the tendency of some to regard occurrences of oil shale and natural gas as indications of the occurrence of petroleum. However, as pointed out in this report, oil shale does not contain petroleum as such, but yields it only as a disintegration product when distilled under suitable conditions. "Thus the occurrence of oil shale is no 'indication of petroleum,' and may have little or no bearing upon the question of the possibility of discovering oil. The occurrence of coal is a similar piece of evidence. . . . The occurrence of natural gas also is not necessarily any indication of petroleum."

It is further remarked that many people erroneously regard saltpans as indicators of petroleum, owing to the frequent association of brine and brine springs with petroliferous strata. Still others have argued that as South Africa provides a unique instance of diamond occurrence, there is no reason why it should not also provide a unique example in the mode of occurrence of

petroleum—an attitude of mind which is indeed absurdly optimistic.

The conditions that require to be considered in connection with the occurrence of oil are (1) the presence of an ample supply of oil-forming carbonaceous material in the sediments, (2) the conditions under which the sediments have been deposited, and (3) the geological structure. According to Mr. Craig, an oil-field can be predicted with certainty where these three conditions are favourable.

After an analysis of the geological conditions prevailing in South Africa, he concludes that the only system of sedimentary rocks in which oil-fields can be hopefully looked for is the Karroo system. Even in this system, however, except along a narrow strip at the southern edge of the Karroo in Cape Province, and possibly also in north-eastern Natal, the tectonic conditions are not favourable; and as regards the occurrence of oil-fields he concludes that the prospects for South Africa are not hopeful.

As regards natural gas there appear to be coal-measure areas in the Transvaal and Natal where it can be obtained in fair quantity, but Mr. Craig is of opinion that supplies of gas under sufficient pressure to supply towns at a distance from the gas-fields are not likely to be found.

As regards oil-shales the tone of the report is rather more hopeful. Numerous oil-shales occur in the Transvaal and Natal coal-measures, and though none of these yields as much oil as the best Scottish oil-shales, some of them yield a fair amount. One shale yielded in a laboratory test 30 gallons of oil and 64 lb. 13 oz. of ammonium sulphate per ton. Another yielded 27·1 gallons of oil per ton, comprising 10·9 gallons of petrol, 12·4 of kerosene, and 3·8 of lubricating oils. Mr. Craig concludes that the prospecting of the folded belt of the Karroo system for crude petroleum and natural gas is of less importance than the development of shale mining and refining; and that all the evidence available at present leads to the belief that an oil-shale industry has good prospects of proving successful.

Grading of Wattle Bark in South Africa. — In the last number of this BULLETIN (p. 117) reference was made to the Government inspection of wattle bark in South Africa, and a list of the official grades was given. Since then it has been decided to amend the descriptions so that the first grade in each class is now called "choice" and the second grade "fair average quality." The classes for grading are now as follows: H. 1, Heavy (choice); H. 2, Heavy (fair average quality); M. 1, Medium (choice); M. 2, Medium (fair average quality); T. 1, Thin (choice); T. 2, Thin (fair average quality); B. G., below grade.

Insect Pests of the Southern Provinces, Nigeria.—Extensive tours were made in 1912 by the late Entomologist of the

Agricultural Department, Southern Provinces, Nigeria, to study the prevalent insect pests, and the results of these and of work done at headquarters are published in the *Bulletin of Entomological Research* (1913, **4**, 191), together with recommendations as to methods of dealing with the pests.

Cotton is attacked by many enemies, among which the red cotton stainer (*Dysdercus superstitiosus*) is the worst; it sucks the juices of the rich, oily seeds and stains the cotton lint with yellow excretory juices, doing an immense amount of harm both to the seed and to the lint. It feeds also on the silk-cotton tree, Hibiscus, and other plants, and so finds food all the year round. No natural enemies have yet been discovered. The remedies are: (1) Keeping the plantations clean and free from weeds and removing silk-cotton trees in their neighbourhood; (2) removing the insects from the plants by means of a net; this is suspended from a wire circle with a deep bend in it reaching to the centre, so that it can be fitted round the stem of the plant; (3) the employment of trap crops ripening earlier than the cotton; from these the stainers can be collected and killed: this plan, however, has not yet been tested; (4) gathering the cotton immediately it is ripe; (5) sunning it well when gathered and constantly turning it over; the stainers then crawl away and can be killed; (6) burning the old cotton stalks, as these, if left, harbour the pest. The native cotton plants reach a height of 6 ft. and more, and are wide-spreading; this renders some of the above methods hard to carry out. It is hoped that by selection for moderate size and a better yield of lint an improved native type may be obtained.

The black cotton stainer (*Oxycarenus Dudgeoni*) has not been so fully studied, and whether it stains the lint seriously is not yet known. It can be combated in the same way as the red cotton stainer. Three boll-worms, *Diparopsis castanea*, *Earias biplaga*, and *Chloridea obsoleta*, seem widely distributed throughout the country; the caterpillars bore into the unopened bolls and devour the seeds. These and the leaf-rolling caterpillars, *Sylepta derogata* and *Zebronia phenice*, might be destroyed by spraying, and by taking care to burn the old stalks and diseased bolls at the end of the season. Lead chromate is suggested as an easily handled and effective poison. The green fly (*Aphis gossypii*) is kept well in check by ladybirds and their larvæ, and by the larvæ of hover-flies, and lacewing flies, which feed on it. Certain beetles feed on the leaves of the cotton plant, but do not seem to be a serious pest; they should, however, be watched for, especially on young cotton, and spraying with lead chromate should be employed if circumstances warrant it.

Cocoa also received attention. *Diacrisia maculosa* is the worst of the caterpillars; it is very active, crawls quite long

distances, and has been frequently observed crossing from cocoa beds to maize, on both of which it feeds, as well as on kola and cotton. Maize and cocoa should therefore not be grown near together when this pest is prevalent. The pod borer is also a serious pest, and to check its ravages the wholesale clearing-up and destruction of neglected pods is essential. Red tree-ants (*Œcophylla smaragdina longinoda*), though they do not injure the cocoa trees, cause great annoyance to the cocoa gatherers by their irritating bites; they form leaf-nests, which should be cut down and destroyed.

Maize and grass are liable to be seriously attacked by swarms of caterpillars; these should be checked by examining the maize fields and lawns and their surroundings at the likely times for small young caterpillars, and if found the grass and bush round the fields should be burnt, and caterpillars on the maize and lawns should be destroyed by spraying. The mealie stalk borer of South Africa, *Calamistes fusca*, has been found, as also have Noctuid caterpillars, which attack the maize cobs; but these have not yet been fully studied in Southern Nigeria.

Maize, when stored, suffers greatly from the attacks of weevils and other beetles. As the natives often store maize in their huts on shelves above the cooking place, so that it is under the influence of the warmth and smoke, experiments were made to ascertain if this method possessed any practical value for storing cobs and seed on a large scale for food and the market, but the results were not encouraging, and fumigation by carbon disulphide is a far more efficient method. A fumigatorium is being built at Ibadan.

Insects affecting yams, rubber trees, mahogany and other plants were also studied; and the need of more pioneer research work is urged as being essential before reliable advice can be given to the native farmers as to methods of economic value for combating the insect pests.

Insect Pests of the Nyasaland Protectorate.—A list of insects collected or bred from various crops in Nyasaland during 1911–13, with some account of their economic importance, is given by the Government Entomologist in the *Bulletin of Entomological Research* (1914, **4**, 347). Cotton seems to be the worst sufferer, and to be attacked by a greater variety of insects than any other crop.

The larvæ or caterpillars of Lepidoptera (moths and butterflies) are the most destructive pests in the country, the three boll-worms doing a tremendous amount of damage. The red boll-worm (*Diparopsis castanea*), *Chloridea obsoleta*, and *Earias insulana*, occur all over the Protectorate, attacking cotton; the second also attacks maize, tobacco seed-pods, and chick-peas; and the third has been found on

garden Hibiscus. The cotton leaf-rolling caterpillar, *Sylepta derogata*, is rare in the Zomba district, but further north on the Lake shore it is a serious pest. *Euxoa segetum*, *Prodenia litura*, and *Phthorimœa heliopa* are serious pests on tobacco; the second also attacks cotton and maize, and has been once found attacking tea. *Busseola fusca* causes great loss by boring in the stems of maize and millet. Mahogany plantations are stripped of their leaves by *Heteronygmia leucogyna*.

Of the Acridiidæ (grasshoppers and locusts) two species are troublesome, eating the leaves of the young tobacco plants in the nurseries; these are *Maura bolivari* and a species of *Chrotogonus*.

Of the beetles (Coleoptera) a few are destructive; among these are: *Lagria villosa*, on leguminous plants in vegetable gardens; *Ootheca mutabilis*, to the flowers of native pumpkins, occurring also on cotton and leguminous crops; *Pachytoma gigantea*, in cypress nurseries by eating the growing points of the young trees; the larva of *Apion armipes*, boring in the stems of cotton plants, causing them to swell at the point of irritation and frequently to break at the first high wind; and the grain weevil, *Calandra oryzæ*, here as elsewhere, is very destructive to stored maize and rice.

A saw-fly, a species of *Athalia*, is a major pest on turnips and cabbages. Several species of aphis are injurious, namely: *Aphis gossypii*, on cotton in certain seasons, especially those with excessive rainfall; the bean aphis and the cabbage aphis (*A. brassicae*); this last is covered with a waxy secretion which makes it difficult to destroy by contact poisons.

Antestia variegata does considerable damage to coffee berries, and *Dysdercus nigrofasciatus* is a major pest of cotton, which it damages both by sucking the seeds and staining the lint.

Development of German Nyasaland.—An account of Lake Nyasa and German Nyasaland, written in response to the offer of a prize by the German Colonial Society, has been published as *Supplement* No. 10 (1914) of the *Mitteilungen aus den Deutschen Schutzgebieten*. The lake is situated in one of the long hollows characteristic of Africa, which lie deeply sunk in the high plateaus; it is over 300 miles in length and about 30 miles in breadth, and runs almost due north and south. Half of its eastern shore and also the northern extremity belong to German East Africa. Although the surface is 1,570 ft. above sea level, it is so deep that its bottom in some parts is below sea level. At the northern end the land rises at first gently but afterwards steeply to a barrier of volcanic mountains. This district is known as Kondeland. On the eastern shore the rise is

rapid to a height above the lake surface of 3,500 ft. and more in the Livingstone mountains and the Matengo plateau. Portions of the mountain area are much higher than this, the highest parts being over 9,000 ft. above sea level. On the western or English shore the slope for the most part is much more gradual.

As a result of these variations in altitude the climate of different places varies greatly; thus the mean annual temperature of Ikombe, at the north end of the lake, is 75° F., and the monthly range is from 69° F. in July to 79° F. in November; whilst at Tandala, which is in the mountains not far from Ikombe, but 5,000 ft. higher, the mean annual temperature is 57·5° F. As regards rainfall the prevailing wind is from the south and south-east, and so the water vapour of the lake is brought with it and deposited as rain at the north end. Most of the rain in the Nyasa district comes in the summer, and generally speaking there is little in winter. In Kondeland the annual fall is always above 40 in. and often 80 in. and more, whilst the south coast of the lake and the Shiré valley generally receive 40 in. or less. The western side of the lake also receives more rain than the eastern.

There are now three elements in the population of Nyasaland, namely: (1) the natives belonging to the various tribes; (2) immigrant coloured races, Arabs, Indians, and Swahilis, differing essentially from the natives in their customs; and (3) Europeans.

The natives formerly produced only what was wanted for their own needs—any store of goods would have excited the greed of robber tribes; but now that they are protected under German rule, they have new opportunities for marketing their produce. Agriculture and cattle raising, and, to a less degree, hunting and fishing, are their chief industries. They grow maize, rice, and various millets such as sorghum and ragi (*Eleusine coracana*), manioc or cassava, and sweet potatoes; in the mountainous parts beans and peas, and plantains in Kondeland. The bamboo is grown for its sap, from which an intoxicating drink is made. Since 1905 wheat and potatoes have been introduced by the missionaries and have been readily adopted, displacing other crops to some extent. There has been quite a large sale of wheat, and some has even been exported to British Nyasaland. Some of the natives find employment as servants to the Europeans, as clerks in the Government service, and as teachers with the missionaries. There are scarcely any large plantations employing many natives, as there are in Usambara in the north of German East Africa. A small percentage, however, leave their homes and seek employment on the roads or on railway building or on the coast.

The number of coloured immigrants is not large; most

of the carrying trade is in their hands, but they take scarcely any part in production, though some Arab planters grow rice and sugar-cane with slave labour in the low-lying part of Kondeland.

The white population is made up of German officials and officers who live at the centres of government; of missionaries who try to grow the supplies necessary for their stations, and beyond that do not produce very much; and lastly there are a few German settlers and some small plantations, but their output is still unimportant. The largest of these, a rubber plantation at Kjimbila, has not yet exported much rubber. Cattle-raising has been the most successful undertaking for the settlers; they also grow rubber, coffee, tea, rice, and sugar-cane.

As regards minerals, coal occurs between Ssongwe and Kiwira, and possibly can be worked profitably when transport facilities to the coast are more favourable. The seams are connected with the sediments of the Karroo formation; they have not been formed *in situ*, so some caution is necessary in estimating their value. There are also large beds of iron ore in the Livingstone mountains, and rich copper ore has been found on the borders of Buanji and Ussangu.

To open up the country the Government has made a network of roads with a view to joining up the different parts of Nyasaland among themselves and with other districts. Further transport facilities to the coast, however, are needed, and railway communication with the coast would make Nyasaland one of the most desirable places of settlement in German East Africa and cause its rapid development. At present transport by carriers from Wiedhafen on the lake to Kilwa on the coast takes about thirty-one days. A southern line from Wiedhafen to Kilwa, or else a branch line from the existing central railway, starting at or near Kilossa, has been thought of, the latter line being most favoured at present.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports published during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

SOILS AND MANURES

THE relationship between the natural vegetation and the capabilities of the underlying soil for crop production, is discussed, with special reference to the Tooele Valley,

Utah, in *Journ. Agric. Research* (1914, **1**, 365). The sage bush (*Artemisia tridentata*) was found to characterise light permeable land, which had a rather low moisture-retaining capacity and was free from large amounts of alkali salts. A good growth of sage bush, as a general rule, indicated land well suited to dry or irrigation farming. On the other hand, a poor stand usually showed on land too poor for profitable cultivation.

Where the Kochia (*Kochia vestita*) type of plants occurred the land was of finer texture and had a higher moisture-retaining capacity than that on which sage bush was growing. Although the first foot of soil was usually fairly free from alkali salts, the subsoil contained a fairly large percentage, and on this account dry farming is stated to be somewhat precarious on this land. Where the shadscale (*Atriplex confertifolia*) type of vegetation occurred land somewhat similar to that occupied by the Kochia type was found, but the content of salts was lower, and as the soil is more permeable, irrigation farming might be possible. Land on which greasewood (*Sarcobatus vermiculatus*) and shadscale were dominant differed from any of the foregoing in being moister during the summer months. It contained much saline matter below the first foot and often also in the top soil. Land of this type, if well drained, might produce good crops under irrigation.

The presence of grass-flat vegetation, of the type of *Sporobolus*, *Distichlis*, or *Chrysothamnus*, was found to indicate land of high moisture content, more or less saline and not suitable for cultivation unless drained. Salt-flat vegetation, such as *Allenrolfea* or *Salicornia*, indicated that the land was extremely saline and not adapted for crop cultivation.

In view of the attention which is being paid to the practice of heating soils as a means of increasing their fertility, a recent paper on "The Effect of Heat upon the Mineral Constituents of the Soil," in the *Journ. Indust. and Eng. Chem.* (1914, **6**, 223), is of interest. The soils selected for experiment were 12 typical Hawaiian samples, and heating was performed in three stages, viz. (1) up to 100° C. for 8 hours; (2) up to 250° C. for 8 hours; (3) ignition over a Bunsen flame. Extracts were made, from each of the samples treated as above, with both water and fifth-normal nitric acid, 5 parts of solvent being used to one of soil. The results for the various mineral constituents may be briefly summarised as follows:

The solubility of the lime and magnesia in water increased with the temperature employed up to 250° C., but a decrease took place on ignition. Nitric acid extracted the largest quantity of lime and magnesia from the samples heated to 100° C., whilst those ignited showed the least solubility.

The phosphates were most soluble, in nitric acid, after ignition; but those heated to 100° C. or 250° C. showed the greatest solubility in water. It is interesting to note that the phosphates in the uncultivated soils were found to be more soluble than in those under cultivation. Potash was found to be most soluble in soils heated to 250° or ignited, the average being in favour of the latter. Contrary to what was found in the case of the phosphoric acid, cultivated soils were found to contain more soluble potash than uncultivated.

Heat produced a striking change in the solubility of the sulphates, heating to 250° C. producing the form most soluble in water, but ignition caused a decrease in the solubility. The largest amount of sulphate was extracted, by nitric acid, from the ignited samples. In many cases, the sulphates were more soluble in water than in nitric acid.

An account of the present condition of the phosphate fields of South Carolina is given in *Bulletin* No. 18, *U. S. Dept. Agric.* These deposits, which have been worked since 1868, still contain enormous quantities of phosphate averaging 61 per cent. of calcium phosphate. Owing to the increased cost of production, which now averages $3·46 per ton, the material cannot be profitably exported and is therefore used locally for the manufacture of "acid phosphate." The increased cost of production has been largely occasioned by the greater quantity of useless overburden, which has now to be removed before the workable phosphate is reached.

Experiments have been carried out, in Java, over a period of four years, in order to determine the suitability of various plants for use as green manures and cover crops. In all, some 53 species were tried, and from the results of the experiments, which are quoted in *Mededeelingen uit den Cultuurtuin*, No. 1, 1913, *Departement van Landbouw, Nijverheid en Handel, Java*, six of these are recommended for use. *Leucaena glauca*, Benth., which has given great satisfaction, may be planted at any altitude from sea level to 3,500 ft. It requires a fairly good soil and produces plenty of seed, but not more than 50 per cent. of this will germinate after keeping for 4 months. It is not of much service as a cover plant, as its leaves soon fall off. *Clitoria cajanifolia*, Barth., was found to be one of the most suitable plants as a cover; the leaves are very tough and are not eaten by animals. It grows best at lower elevations than 2,000 ft., and is very suitable as a shade for coffee or Hevea. *Tephrosia candida*, *T. Vogelii*, and *T. Hookeriana* have the advantage over the foregoing in that they will grow well on a much poorer soil. *T. Hookeriana* can be cut back several times at intervals of 5 months, but the old plants suffer from a stem disease. *T. candida* grows more vigorously than the last mentioned and is able

to withstand considerable drought. It is a good cover crop and excellent as a green manure. *Desmodium gyroides*, DC., is the most valuable of the Desmodium species, and grows in a bushy form producing many leaves. It appears to be rather subject to attack by a fungoid disease, *Corticium salmonicolor*, after being pruned a few times.

Some interesting results obtained by spraying fruit trees, during the dormant season, with solutions of sodium nitrate are given in *Journ. Agric. Research* (1914, **1**, 437). It had been observed previously that the rest-period of a number of woody plants was materially shortened by treating their dormant shoots with nutrient solutions, and the experiment was tried of treating apple and pear trees in certain orchards in California with solutions of sodium nitrate and caustic potash, the latter being added for its insecticidal properties.

The mixture used, which consisted of 50 lb. of sodium nitrate and 7 lb. of caustic potash to each 50 gallons of water, was applied at the rate of 7 gallons of solution per tree, care being taken that all the small twigs were thoroughly drenched. Check trees were selected, and were either untreated or had 50 lb. of sodium nitrate applied *as a manure*. It was found that the sprayed trees blossomed about two weeks earlier than the check trees, and there was a marked improvement in the colour, abundance, and vigour of the foliage.

The experiments have only been continued over two seasons, but the results indicate that, in the case of certain varieties of apples and pears, an increased yield is obtained by winter spraying with sodium nitrate and caustic potash. The authors point out, however, that there would be some danger of injury from frost in the case of trees forced into bloom earlier than usual.

A further account of the results of the manurial experiments which are being carried out in certain German Colonies (cf. this BULLETIN, 1913, **11**, 522) is given in Nos. 2, 3, and 4 of *Dungenversuche in den Deutschen Kolonien* (German Colonial Office, 1913). Full details are given of the experiments on the economic plants cultivated in Kamerun and Togoland (No. 2), German East Africa (No. 3), New Guinea and Samoa (No. 4).

FOODSTUFFS AND FODDERS

Maize.—According to the *Rep. Dept. Agric., Union of South Africa*, 1912–13, p. 157, the following definite breeds of maize have been produced: (*a*) An earlier-maturing "Hickory King"; (*b*) an improved-grain type of early maize; (*c*) some drought-resistant types; (*d*) a promising type, comparing favourably with the high-priced Bessarabian and South-east European types. These types are now being fixed, a process which requires three to five seasons to complete.

An account is given in *Journ. Agric. Research* (1914, 1, 293) of the study of the type of maize grown by the Hopis and other agricultural Indians of New Mexico and Arizona. The type possesses two special characteristics, which enable the corn to succeed in dry regions, namely: its ability to force the growing shoot to the surface of the soil when planted at the depth of a foot or more, and the development of a single large radicle that rapidly descends during the critical seedling stage to the moist subsoil.

The Pueblo Indians have strains sufficiently productive to compare favourably with improved varieties, even when grown under irrigation. Experiments are suggested to determine the possibility of utilising this type of maize in semi-arid regions.

Wheat.—The results of experiments with wheat at the Lyallpur Agricultural Station are given in Appendix No. VI. to *Rep. Dept. Agric., Punjab*, 1912–13, and show that hot-weather ploughing is more beneficial than ploughing during the rains. It was found that the use of calcium nitrate as a manure produced increased yields, but only in one plot in four was the application profitable. It was, in that case, applied at the rate of 168 lb. per acre. Further trials with wheat No. 9 indicate that it produces large yields only on good land, and yields better when sown after cotton than when it follows wheat.

Sugar.—The results obtained by a mission specially appointed to investigate the froghopper pest in Trinidad are contained in *Bulletin Dept. Agric., Trinidad and Tobago* (1914, **13**, 45). The following recommendations are made and discussed: (1) A search should be made for efficient parasites of the eggs or adult form of the froghopper. (2) The Syrphid fly should be put on to the early broods of froghoppers. (3) Abandoned lands adjacent to cane fields should be either put under a cover crop or grazed. (4) Trash should be removed from the field, and not returned till well broken up and sodden. (5) As soon as early broods of froghopper nymphs appear, they should be destroyed by hand picking; the early adult broods should be destroyed by kerosene-lysol emulsion, or by squeezing the leaf-sheaths. (6) The later large swarms of adults should be destroyed, as far as possible, by trap-lights.

Teosinte.—The cultivation of teosinte (*Reana luxurians*) as a fodder plant is described in the *Cyprus Journ.* (1914, No. 32, p. 741). If irrigated, the plant yields three or four crops per season, amounting to 75 to 90 tons of green fodder per acre. It is readily eaten by cattle.

Oils and Oil Seeds

Coconuts.—The results of experiments in the cultivation of coconuts on irrigated and non-irrigated land at Maha-

illuppallama in the North-Central Province of Ceylon have been published (*Bulletin* No. 7, 1913, *Dept. of Agric., Ceylon*). The principal object of the experiments has been to determine whether the trees will thrive when dependent on natural rainfall helped out by a minimum of irrigation during severe drought, irrigation being supplemented by thorough cultivation with modern cultivating machinery. The experiments are not completed yet, but have already indicated that coconuts will do very well in this district under irrigation with a reasonable amount of cultivation; on unirrigated land which was not cultivated the palms did not thrive, and have been very susceptible to attacks of red beetles (*Rhyncophorus signaticollis*).

The coconut palm is only grown in Burma as a garden tree and not on a large plantation scale, although there is abundant land suitable for coconut cultivation in the coast districts and surrounding islands. The questions of soil, methods of cultivation, and maintenance of plantations are discussed by Sawyer in *Bulletin* No. 11, 1913, *Dept. of Agric., Burma*. Special attention is given to methods of draining and the formation of new plantations.

The cultivation of coconuts on the west coast of Borneo is described in *De Indische Mercuur* (1913, **36**, 1971). Details of cost of establishing and running plantations are also given.

An increased number of coconuts was exported from Dominica in 1912, although not much attention appears to have been paid to planting recently (*Rept. Agric. Dept., Dominica*, 1912–13, p. 17). Fairly large areas of land suitable for coconuts are available. The trees probably flourish best in valleys near the sea on the westward side of the island, where the rainfall is over 100 in. per annum. As yet no diseases have been noticed.

Advantage is being taken by planters in the Panama district of the large amount of labour set free by the completion of the Canal (*Phil. Agric. Rev.*, 1914, **7**, 38), and land for coconut and fruit planting is being bought up rapidly.

The present conditions and possibilities of coconut planting in tropical America are discussed briefly in the *Tropical Agriculturist* (1913, **41**, 374). The coconut palm grows well throughout Central America and the tropical regions of South America.

The palm weevil (*Rhyncophorus palmarum*) is stated to be on the increase in St. Vincent (*Rept. Dept. Agric., St. Vincent*, 1912–13, p. 13). This is probably due to the destruction of the gru-gru palms (*Acrocomia* sp.), which are being removed in clearing areas for cotton planting. The gru-gru palms are often destroyed by merely chopping cuts in the trunks; the larvæ of the beetles develop in these cuts and kill the tree. It seems only reasonable to

suppose that with the removal of the gru-gru palms the beetles will transfer their attention to the coconut palms.

In British Guiana the larvæ of a nocturnal moth, *Castnia dædalus*, Cramer, have caused damage to coconut palms (*Journ. Bd. of Agric., Brit. Guiana*, 1913, **7**, 87). The larvæ measure up to 4 in. in length and burrow between the leaf bases and the trunk, causing the branches to drop off and producing longitudinal furrows on the trunk; in cases of severe attack the trunk is weakened to such an extent that it breaks when subjected to strong gusts of wind. Trees should be examined periodically and the lower branches of attacked trees should be cut away until the larvæ are found and destroyed.

Serious damage to coconut plantations in Samoa is being caused by the rhinoceros beetle (*Oryctes rhinoceros*, L.). The distribution of this pest, its natural enemies, and the means of destroying it are fully discussed by Friederichs in *Der Tropenpflanzer* (1913, **17**, 538, 603, 660). The most effective method appears to be the formation of traps for the larvæ, composed of heaps of decaying wood and cocoa husks; the beetles are attracted by the smell of the decomposing cocoa husks, and lay their eggs in the heaps; the larvæ can then be destroyed when the heaps are turned over periodically. The most important point in this article appears to be the discovery of a fungoid disease which attacks the larvæ and kills them. This fungus, *Metharrhizium anisoploe*, can be used to inoculate the heaps of rubbish in which the beetles lay their eggs, and the larvæ which hatch out are then infected and die. Trials with this fungus have proved the practicability of this scheme, which is favourably spoken of by the manager of one of the large plantations and is being taken up by planters.

Ground Nuts.—According to the *Indian Trade Journal* (1914, **32**, 199) the total area under ground nuts in the ryotwari villages of the Madras Presidency in 1913 was 751,200 acres, an increase of 19·1 per cent. on the area reported as sown during 1912. Exports of ground nuts from the ports of the Presidency show a steady increase, and during 1912–13 amounted to 316,548 tons. It is stated that 80 per cent. of the shelled ground nuts imported by Marseilles are from the Coromandel coast, and the average area under ground nuts in the Madras Presidency during the five years ending 1911–12 has represented 70 per cent. of the total area under ground nuts in British India. The ryots are stated to be abandoning other crops for ground nuts on the dry lands, but are at present hampered by lack of decorticating machinery. In view of the steady increase in the exports of ground nuts, a scheme has been outlined by the Chairman of the Madras Port Trust Board for the provision of additional storage and other facilities for the ground nut trade at Madras.

According to *Der Tropenpflanzer* (1914, **18**, 49) an agreement has just been concluded between the Belgian Government and an Antwerp firm for the leasing of 40,000 hectares of land in the Belgian Congo. The Company is to be allowed its own choice of territory, but is bound to utilise the land for the cultivation of ground nuts and maize, and is further required to show yields of 125, 250, and 500 kilograms per hectare of seed or grain by the end of 1920, 1928, and 1938 respectively. On the expiration of the contract in 1942 the land is to become the property of the Company at a rental of 25 centimes per hectare, provided that the yield of 500 kilograms per hectare is maintained. The capital of the Company is 3½ million francs.

An account is given in *L'Agricoltura Coloniale* (1914, **8**, 171) of experiments which have been made in Italian Somaliland with varieties of ground nuts, from which it appears that the most satisfactory yields of both kernel and oil were obtained from the Haut-Saloum and Gambia varieties.

Oil Palm. — According to Amman (*L'Agronomie Colon.*, 1913–14, **1**, No. 7, p. 9) the soil of Gaboon is very favourable to the growth of oil palms, an average yield of 220 lb. of fruit-heads per tree in a year being obtained. The author states that the fruits are larger than those grown in any other part of Africa. The average weight of a fruit in one sample was 11·2 grammes—from the analytical figures given it is evident that the fruits were almost dry; but allowing for this fact, the average weight is close to but does not exceed that of a sample of the "Ak-por-ro-jub" variety from Nigeria examined at the Imperial Institute, the fruits of which had an average weight of 12·8 grammes in a moist condition (cf. this BULLETIN, 1909, **7**, 377).

Interesting details concerning the yields of fruit, palm oil, and kernels obtainable from palms in Lower Guinea are given by Nicholas (*L'Agronomie Colon.*, 1913–14, **1**, No. 5, p. 138). The crop obtained during a whole year was weighed, the fruit being harvested in October 1911, and in January and May 1912. A group of 590 trees yielded 2,521 bunches of fruit. The total weight of the fruit bunches was 44,220 lb., and they yielded 22,511 lb. of fruit, the average weight of a fruit-bunch being 17½ lb. The yield of palm oil by the usual native methods was 2,068 lb., equivalent to 8·1 per cent. by weight of the fruit. The yield of kernels was 4,519 lb., equivalent to 17·7 per cent. of the fruit.

According to Hallet (*Journ. d'Agric. trop.*, 1914, **14**, 31) the oil palm grows well in Malaya. In a small plantation of 150 trees five to six years old, each tree is stated to have borne from 200 to 300 kilograms (440 to 660 lb.) of fruit—this is presumably a misprint for 20 to 30 kilograms; the trees reach the full bearing period by the sixth year.

According to researches carried out by Elsdon (*Analyst*, 1914, **39**, 78), palm-kernel oil very closely resembles coconut oil, and no certain means were found of distinguishing these two oils. The results of the investigation are open to criticism, as the specimen of palm-kernel oil used was not extracted from palm kernels by the author, but was purchased, and may therefore not have been genuine unadulterated oil.

Tung Oil.—Experiments are in progress in the West Indies in growing *Aleurites Fordii* (*W. I. Agric. News*, 1913, **12**, 403). The seeds were obtained from Foochow through the Botanical and Forestry Department, Hong Kong, and were distributed to Antigua, St. Kitts, Montserrat, Dominica, and St. Lucia. In all the islands germination and early development were satisfactory, but on being planted out in the field at low elevation very little progress was made. As the trees thrive best on dry and rocky hillsides (cf. this BULLETIN, 1913, **11**, 448), a few plants are at present under trial in the Dominica hills, although it is feared that the rainfall may prove too heavy. Apparently the tree has shown more promise in St. Kitts, as forty plants have been raised in the nurseries and are being distributed in the Presidency.

Miscellaneous.—Fruits of the Sagdo tree, obtained from the Ngaundere district, Kamerun, yield kernels containing 45 per cent. of oil, equivalent to about 20 per cent. on the whole fruit. The analytical constants of the oil are given in *Chem. Rev. Fett u. Harz Ind.* (1914, **21**, 57). The oil is non-drying and possesses a bitter taste which would render it unsuitable for edible purposes. According to a commercial firm, however, the oil is suitable for the manufacture of soap.

Results are given (*loc. cit.*) of the examination of seeds of *Melampyrum arvense*, which are used extensively as an adulterant of Russian linseed and hemp seed. The seeds contain 35 per cent. of a somewhat viscous oil which exhibits no drying properties and is liquid below 0° C. The analytical constants of the oil somewhat resemble those of castor oil, suggesting that it might be used technically as a substitute for the latter.

Seeds of *Hibiscus cannabinus* ("Da") contain 20 per cent. of a bright yellow drying oil, capable of being used for the manufacture of linoleum and varnishes (*L'Agronomie Colon.*, 1913–14, **1**, No. 6, p. 161). The samples examined were grown in the Niger valley and Upper Senegal, and it is stated that under normal conditions a yield should be obtained of about 500 kilos. of seeds per hectare.

Seeds of *Sinapis juncea* are stated to yield a fatty oil suitable for use as an edible oil (*Chem. Rev. Fett u. Harz Ind.*, 1914, **21**, 85).

According to *Der Tropenpflanzer* (1913, **17**, 710), the fruits of *Camellia japonica* yield an oil capable of being used as a lubricant or for the manufacture of soap. The article states that the tree is grown principally in Kiushiu and the surrounding islands, and also in the Idzu Islands, to the south of the Bay of Tokio. Oil to the value of about £10,000 was exported in 1911, it is said principally to Great Britain and China, but it is thought that exports will increase greatly when the oil becomes better known.

Essential Oils

Bay Oil.—As the result of investigations conducted over a period of two years in Montserrat, the *Rep. Bot. Station and Expt. Plots*, 1912–13, states that the cultivation of the bay tree could be developed probably as a small industry. Monthly distillations were carried out to determine the best time for picking the leaves, and experiments made to ascertain whether the export of the dried leaves or oil would prove more profitable. A study of the differences in yield and quality of oil from selected trees seemed to indicate that selection would lead to improved results.

The amount of bay oil and leaves exported from the island in 1912 was 43 gallons and 12,289 lb. respectively; these exports were derived from uncultivated forest trees.

Star-anise Oil. — The *Journ. d'Agric. trop.* (1914, **14**, 40) contains an article on the star-anise oil industry of the Langson district of Tonkin, the area from which two-thirds of the star-anise oil imported into Europe is derived (see also this Bulletin, 1913, **11**, 159). The star-anise tree (*Illicium verum*) flourishes best in that part of Tonkin which has a moist and somewhat variable climate, and especially on hill sides with a red clay-schist soil. The seeds are said to lose their power of germination rapidly, and the Chinese preserve them in layers of dry earth. The plants should at first be well sheltered from the sun, and then require a great deal of attention until the eighth or tenth year. The fruit appears between the tenth and fifteenth year, and during a period of 20 to 35 years the trees are in their prime, and should produce two crops a year. Five tons of green fruits per hectare (2·47 acres) is stated to be a good yield for a mature plantation. Mention is made of the diseases and insect pests to which the tree is subject. In the event of a bad crop of fruits the natives are now beginning to distil the leaves, which yield about a tenth as much oil as the former. Although the leaf oil has not quite the same characters as those of the fruits (cf. this Bulletin, *loc. cit.*), it is stated that local buyers do not discriminate between them. The yearly production of oil from Tonkin is variable. The output in 1910 was 66 tons, rising to 100 tons in 1911, and falling again to 46 tons in 1912.

Turpentine Oil.—Experiments on the utilisation of tree stumps and mill-waste by distillation (cf. this BULLETIN, 1909, **7**, 73; 1911, **9**, 421) have been conducted recently in Canada and in the United States with wood obtained from the Douglas fir (*Oil and Colour Trades Journ.*, 1914, **45**, 383). By steam distillation the best result obtained was 4·1 gallons of turpentine oil per "cord" of wood, weighing 3,800 lb. By destructive distillation the average yields obtained per cord in two test runs were wood alcohol 100 per cent. strength, 2·3 gallons; turpentine oil, 1·6 gallons; other oils, 3·8 gallons; tar, 15·3 gallons; acetate of lime (80 per cent. strength), 62·9 lb.; charcoal, 800 lb. It is stated that as these proportions of turpentine and other oils, and tar, are lower than those commonly obtained from waste wood of the Norway and long leaf pines, the use of Douglas fir wood on a large scale for distillation purposes is not anticipated.

RUBBER

Hevea brasiliensis.—Results of work by Bateson on the food reserves of Hevea trees are summarised briefly in a report on Agriculture in Malaya in 1912 (*Bulletin* No. 18, 1913, *Dept. Agric., Federated Malay States*). The work was not completed when the report was published, but the results already obtained indicated that (1) Normal tapping does not cause such a depletion of starch reserve as to necessitate more conservative systems of tapping, with regular periods of rest; (2) Tapping on adjacent quarters seems more favourable to the tree and also more advantageous than tapping on opposite quarters; (3) Defoliation during "wintering" caused marked diminution of starch, but the facts observed did not point to the necessity of resting trees during this period.

Three and a half year old Hevea trees are making satisfactory growth, and are in healthy condition at Kampala, Uganda (*Ann. Rept. Dept. Agric., Uganda*, 1912–13, p. 11). The trees average a little over 6 in. in girth at 3 ft. from the ground; a number measure between 6 in. and 9 in., but none are large enough yet for tapping.

Hevea seed and young plants are much in demand by natives in the Gold Coast (*Rept. Agric. Dept., Gold Coast*, 1912, p. 15). Small isolated plantations are being made all over the country, but it will be some years before much rubber can be produced. A number of plantations have been made by Europeans in the Colony, and on some of these tapping has been started and rubber from them has been sold.

Spring has carried out (*Agric. Bulletin, Fed. Malay States*, 1914, **2**, 146) some experiments to ascertain the value of tapping by gouge in the usual way as compared with "pricking" with a Northway four-point serrated knife. Fifty four-year-old trees were tapped by each method

on the quarter system. The yield of rubber over a period of six months was practically the same in each case; no injury was done to trees by the Northway serrated knife, but the cost of labour in using it was about double that of tapping with the gouge.

In Ceylon a beetle, *Mæchotypa verrucicollis*, Gahan, has been found to attack young Hevea plants (*Trop. Agriculturist*, 1914, **42**, 41). The plants attacked were mostly stumps which had withered, and which probably would not have grown. Spraying with lead arsenate is recommended.

Although "black scale" (*Lecanium nigrum*) is not considered a serious pest to Hevea trees in Ceylon at present, Rutherford (*loc. cit.*) recommends that it should be destroyed whenever possible, as it may become serious.

Manihot species.—Although *M. dichotoma*, *M. piauhyensis*, and *M. heptaphylla* have made rapid growth at the Government Plantation, Kampala, Uganda (*Ann. Rept., Dept. Agric., Uganda*, 1912–13, p. 11), they can only be grown in sheltered positions, as all the trees have suffered severely from storms. The claim that these species are less liable to damage by wind than *M. Glaziovii* appears to be incorrect.

Zimmermann gives the results of examination of a number of samples of Manihot rubber prepared by various methods in German East Africa (*Der Pflanzer*, 1914, **10**, 67). Most of the samples were valued in Germany by brokers, and also tested technically. The results, which are of particular interest at the present time, when so much attention is being given to vulcanisation tests (cf. this BULLETIN, 1914, **12**, 76), show that brokers' valuations, based on the appearance of the raw rubber, are of little value as indications of the real value of the rubber for technical purposes. A point which is very strongly brought out is the uselessness of attempting to ascertain the technical value of a series of samples by curing every sample for the same length of time; it is necessary to ascertain by experiment the correct time of cure for each specimen. Thus, two similar samples, A and B, gave figures for tensile strength of 20 and 44 kilograms per square centimetre respectively when cured for two hours; but when A was cured for 2 hours 40 mins. its tensile strength rose to 41. The results show that Manihot rubber of excellent quality may be prepared by the Lewa method, or by coagulation with calcium chloride.

Ficus species.—Descriptions of the different species of *Ficus* occurring in the Belgian Congo are given by de Wildeman (*Bull. Soc. Roy. Botan. Belgique*, 1913, **52**, 196).

The different species of boring insects attacking *Ficus elastica* are described by Dammerman (*Mededeelingen van de Afdeeling voor Plantenziekten*, No. 7, 1913, *Dept. Landbouw Nijverheid en Handel, Java*).

Guayule.—Examination of three specimens of *Parthenium argentatum*, grown in Mexico in localities where different conditions of rainfall obtain, has been made by Lloyd (*Journ. Soc. Chem. Ind.*, 1914, **33**, 107). The results showed that wild guayule plants grown in districts with an abundant rainfall resemble plants grown under irrigation in containing less rubber than those growing under desert conditions. The amount of resin secreted does not seem to be affected by the quantity of soil water available, and no evidence was obtained to show that rubber and resin secretion are related.

General.—Trees of *Mascarenhasia arborescens*, 4 to 6 in. in diameter, have been tapped in Mauritius (*Ann. Rept. Forests and Gardens, Mauritius*, 1912, p. 14), but a very poor yield of rubber was obtained.

Dubard and Eberhardt state that the rubber of *Tabernæmontana annamensis*, a plant abundant in certain parts of Annam, is resinous, but that when de-resinified it is of good quality (*Journ. d'Agric. trop.*, 1913, **13**, 382). Two rubber vines (*Parabarium* spp.) also occur in Indo-China and are stated to yield rubber of fair quality, but no information is given as to the possibility of exploiting these species.

A simple pricking instrument has been devised by Ledeboer (*India Rubber Journal*, 1914, **47**, 520). It may be described as a number of needles mounted in a wooden handle. No results of trials with the pricker are yet available, but it is simple, and in the hands of unskilled coolies would probably be less likely to damage trees than more complex prickers.

From the results of experiments carried out by Marquis and Heim (*Bulletin de l'Office Col.*, 1913, **6**, 406), it is stated that one of the causes of tackiness of rubber is the absorption of atmospheric oxygen, a very small quantity of which appears to combine with the rubber; the tendency to tackiness is said to be entirely absent in smoked rubbers.

The results of researches carried out by Stevens on the influence of nitrogenous substances and resins on the vulcanising properties of rubber (*India Rubber Journal*, 1914, **47**, 403) controvert the often-quoted statement of Weber, that rubber freed from resin will not vulcanise. Stevens finds that the removal of resin does not prevent vulcanisation, but that vulcanised rubber made from resin-free rubber deteriorates rapidly on keeping.

Fibres

New Zealand Hemp.—It is stated in the *Annual Report of the New Zealand Department of Agriculture, Industries and Commerce for* 1913, that the high prices ruling for New Zealand hemp on the London market in that year gave

an impetus to the industry and encouraged owners of phormium estates and hemp millers to re-establish operations in districts in which, owing to the scattered nature of the plants, the business had for several seasons been unremunerative. Unfortunately the plants in the principal phormium-growing districts were attacked by a leaf-disease, and efforts are being made to find a remedy for this affection. Some of the hemp exported was of high quality, but much inferior fibre is still produced owing to the use of old-fashioned machinery. The demand for the higher grades was in excess of the supply. The exports in 1912–13 amounted to 120,452 bales of hemp, 41,036 bales of tow, and 7,777 bales of "stripper-slips," as compared with 85,684 bales of hemp and 23,433 bales of tow in 1911–12.

Sisal Hemp.—According to the *Report for* 1912–13 *on the Trade and Commerce of the Territory of Hawaii* (*Dipl. and Cons. Reps.*, No. 5,253, *Ann. Ser.* [Cd. 7048–70]) the area under Sisal hemp amounted to 1,800 acres, and the crop was estimated at 1,000 bales, each of 600 lb. The fibre is of excellent quality and is whiter and more valuable than the Mexican product. The exports for 1912–13 were 325 tons, of value £9,212. The growth of the plants has been retarded by a severe drought in the lowland plantations, and in consequence a decline in the production has occurred. In the upland districts, however, excellent results have been achieved.

Cotton

Egypt.—Reference has been made in this BULLETIN (1913, **11**, 354) to the damage which has been caused in Egypt by the pink boll-worm (*Gelechia gossypiella*). During 1913 this insect caused more damage than all the other cotton pests together. Experiments have been carried out by the Ministry of Agriculture on methods of destroying the pink boll-worm, and an account of these is given in the *Agric. Journ. of Egypt* (1913–14, **3**, part 2, p. 73). It was found that it is necessary not only to fumigate the cotton seed, but also to destroy the hibernating worms in the bolls left on the stalks standing in the field and stacked for fuel, and it was also considered desirable to fumigate the ginneries and cotton seed stores at the close of the ginning season. Various methods of destroying the larvæ in cotton seed were studied, and the three following were found to be effective and applicable commercially. (1) Treatment with hot air at a temperature of about 80° C.; (2) fumigation with carbon disulphide, hydrocyanic acid, or sulphur dioxide; (3) immersion in "Cyllin" solution (0·1 per cent.) for 24 hours. The first two methods can be applied on a large scale at the time of ginning, and the third only immediately before sowing. No treatment is of avail when the seed is in sacks, owing to the difficulty of penetration. In the same

publication (p. 103) a description is given of a parasite of the pink boll-worm. The larvæ of this insect (*Pimpla roborator*, Fabr.) resemble fly maggots and are found in cotton seeds excavated by the pink boll-worm, lying beside the boll-worm and parasitic on it. Reference is also made (p. 127) to experiments carried out with the object of converting the cotton stalks into charcoal, and thus utilising the stalks whilst simultaneously destroying the pink boll-worm; it is shown that such charcoal can be sold at a price which more than covers the cost of its manufacture.

India.—The experimental work carried out at the Agricultural Stations in Bombay continues to make good progress. In the *Ann. Rep. Dept. Agric., Bombay Presidency, for the year* 1912–13, it is stated that a pure variety of "roseum" cotton has been selected, which is much superior in yield and ginning percentage to the other types constituting the mixture grown at Khandesh. It matures early, and the bolls open well and uniformly. Seed of this variety, sufficient for 352 acres, has been distributed to some of the best cultivators. The distribution of imported Navsari seed in the vicinity of Dharwar has been continued, and the crops have realised much higher prices than the local Kumpta. Cambodia cotton was grown extensively near Gadag, and, in spite of an unfavourable season, large quantities of cotton were obtained and realised good prices. An investigation has been undertaken at Gadag with a view to improving the Dharwar American cotton, which is composed of two distinct varieties, Upland Georgian and New Orleans. The seed of these varieties has been separated, and experiments are being made to determine whether the deterioration in yield and quality of the Dharwar cotton is due to its being a mixture. Cambodia cotton gave good results in North Gujerat, and in one case a crop of 1,592 lb. of seed-cotton per acre was secured. On the Jamrao Canal in Sind considerable success has been obtained with "Triumph" American cotton.

An account of recent work in the Punjab is given in the *Report of the Operations of the Dept. Agric., Punjab, for the year ending the 30th June*, 1913. Several strains of American cotton have been obtained which give large yields and good staple. American cotton is now established firmly in Lyallpur and Jhang, and will probably succeed also in Shahpur. The progress made with the indigenous cottons has not been so satisfactory, but experiments are being conducted to ascertain which type in each of the local mixtures is most profitable and to effect its cultivation in the particular locality.

In the *Report on the Operations of the Dept. Agric., Madras Presidency, for* 1912–13, it is stated that efforts are being continued to improve the cottons by selection with respect to the quality of lint, the ginning yield, and the

yield per acre. At Koilpatti an attempt is being made to secure a strain of Karunganni cotton which will ripen rapidly and thus be suitable for North Tinnevelly, where the season is not usually favourable for ordinary Karunganni, and promising results have been obtained. At Hagari and Nandyal new strains have been produced which give a higher ginning yield and cotton of a better colour than the usual varieties.

West Indies.—An account of the cotton industry in the St. Kitts-Nevis Presidency is given in the *Report on the Botanic Station, St. Kitts-Nevis*, 1912–13. The total area planted amounted to about 5,500 acres, or 900 acres more than that of the previous year. Of 2,000 acres devoted to the crop in St. Kitts, 1,350 acres were planted as an intermediate crop with sugar-cane. This practice has proved very profitable, and it has been found that the crop of cotton taken from the land does not adversely affect the subsequent cane crop; in fact, it is claimed that the good cultivation and tillage of the cotton plants cause the returns from the canes to be above the average. The cotton realised prices ranging from 1*s.* 6*d.* to 1*s.* 8*d.* per lb. The area planted in Nevis was 2,500 acres, an increase of 500 acres over that of the previous season, but the crop was seriously affected by unfavourable meteorological conditions and by the attack of caterpillars. In Anguilla, about 1,000 acres were planted, and the crop exceeded that of any previous year. The introduction of cotton into this island has given rise to a flourishing and prosperous industry, which has proved of great benefit to the inhabitants.

In St. Vincent the cotton crop was injured by the prevalence of continuous rain during the ripening period. Such weather not only reduces the size of the crop but also tends to lower its value by increasing the proportion of "wasty" cotton. The *Report on the Agric. Dept., St. Vincent*, 1912–13, states that the production amounted to 428,032 lb. of Sea Island cotton and 58,737 lb. of the Marie Galante variety. Sakellaridis cotton has been found to give excellent results in the Southern Grenadines, but in St. Vincent it has proved very susceptible to angular leaf-spot disease. Selection experiments have been carried out with the object of obtaining plants resistant to angular leaf-spot disease, anthracnose, and West Indian leaf mildew.

According to the *Report on the Botanic Station and Experiment Plots, Montserrat*, 1912–13, the area under cotton in Montserrat in that year was 2,063 acres, and the exports amounted to 290,390 lb., of value £18,478. Although it has generally been considered that June and July are the best months for sowing, it has now been found that with earlier planting the probability of obtaining a good second crop is increased. Experimental work has been continued and has yielded results of direct benefit to growers. Sakel-

laridis cotton grows well in the island, but is not recommended for cultivation on a large scale, as, owing to the readiness with which the lint falls from the bolls, a number of pickings are required. Abassi and Mitafifi also give good results. Attempts are being made to obtain a hybrid of the St. Eustatius native and Sea Island strains with a view to the production of a plant having the sturdy habit of the indigenous form and bearing lint of the Sea Island type.

Australia.—It is well known that large areas in Queensland and New South Wales are eminently adapted for cotton growing. The *Reports of the Dominions Royal Commission* [Cd. 7172, 7173, and 7210] record the evidence taken and the report issued with reference to this subject. It was stated by some of the witnesses that the Australian workers have an objection to the industry on account of the labour of picking, which they regard as mean and petty, and that there is not sufficient woman and child labour available to do the work. Moreover, it was suggested that the heavy cost of picking, due to the high price of labour, would render it impossible for Australia to compete with countries in which black labour can be obtained at low rates. These difficulties, however, are not regarded as insurmountable. A generous offer of co-operation towards the establishment of a cotton industry was received by the Commissioners from the British Cotton Growing Association, who urged that an agriculturist with special experience of cotton growing should be engaged for three years, and attached to one of the local agricultural departments. The Association promised to assist by a monetary grant, by provision of seed for experiments, by undertaking to superintend the sale of cotton and to guarantee a minimum price of 6½*d.* per lb., and by various other means. It was stipulated that the offer should not apply to cotton grown from perennial varieties or from ratooned plants. Both the Commonwealth and Queensland Governments have expressed themselves in agreement with the British Cotton Growing Association on all matters of principle, and it is hoped that a successful cotton growing industry will shortly be established on a permanent basis.

German Colonies.—A report on the progress of cotton growing in the German Colonies during 1912–13 (*Verhandlungen der Baumwollbau-Kommission des Kolonial-Wirtschaftlichen Komitees*, 1913, No. 1) states that cotton is at present Germany's most important Colonial product, and that in spite of numerous difficulties the industry has steadily grown from year to year. In German East Africa, about 22,000 hectares (54,400 acres) were devoted to the crop in 1912–13, of which 6,400 hectares (15,800 acres) were cultivated on the plantation system and the remainder planted by the natives. The chief centres of the industry

are the districts of Lindi in the South and Mwansa on Lake Victoria. In Togo, the expansion of cotton growing is limited to Central and Southern Togo owing to the unfavourable climatic conditions of the interior of the Colony. The production in German East Africa and Togo together amounted in 1912 to 9,730 bales of 250 kilos. (550 lb.). The estimated yield for the cotton season of 1913–14 is about 12,000 bales from German East Africa and 2,000 bales from Togo. In Kamerun, the work at the Pittoa Experiment Station near Garua has progressed so well that the cultivation can now be undertaken at Adamawa on a large scale. There are still difficulties, however, with regard to markets and transport. In order to introduce the cotton to the German spinning industry, the Colonial Economic Committee has set aside an amount not exceeding M 10,000 for the purchase of cotton produced and ginned in Adamawa.

Morocco.—It is reported in *Bulletin* No. 59, *Association Cotonnière Coloniale* (1913) that a study of the conditions in French Morocco has shown that cotton will grow in the plains of Gharb, in the Chawa, and better still in the Marakesh region, but that the cultivation can only be carried on remuneratively with the aid of irrigation. The necessary irrigation could however be easily organised. Special advantages for cotton growing offered by Morocco are that suitable land can be obtained very cheaply, and that, owing to its proximity to Europe, the cost of transport would be low.

Hawaii.—According to the *Report for* 1912–13 *on the Trade and Commerce of the Territory of Hawaii* (*Dipl. and Cons. Repts. No.* 5,253, *Annual Series* [Cd. 7048–70]), the area devoted to cotton in 1912–13 amounted to 300 acres, and yielded a crop of 250 bales of 500 lb. each. Serious damage has been caused by the pink boll-worm, and the export of cotton seed and husks has been prohibited in order to prevent the dissemination of the pest.

Brazil.—Cotton growing has made great progress recently in Brazil. It is stated in the *Journ. d'Agric. Trop.* (1913, **13**, 376) that the exports increased from 3,565 metric tons in 1908 to 16,774 metric tons in 1912. A remarkable advance took place in the early part of 1913, the exports during the first eight months of that year amounting to 21,564 metric tons as compared with 8,419 tons in the corresponding period of 1912. The exports, however, probably do not represent more than about one-fourth of the total production, which was estimated in 1912 as between 60,000 and 65,000 tons.

Tobacco

The *Rep. Dep. Agric., Union of South Africa*, 1912–13, pp. 195, 199, 204, 209, 216, records the results of variety,

curing, and seed selection trials at the various experiment stations and private farms. At Rustenberg, Transvaal, it has again been found that in growing "yellow leaf" the best results are obtained on a turf soil. The flue curing varieties "Yellow Prior," and "Boyd 1269," yielded 1,535 lb. and 1,448 lb. per acre respectively, and the air-curing varieties "Burley x Swazie" and "Swazie x Burley" yielded 1,464 lb., and 1,440 lb. per acre respectively. These two hybrids show great promise of becoming useful varieties when properly fixed; the leaf is broader and finer than the leaf of "Swazie," but not so large as the leaf of "Burley." Of the dark varieties tried the best yields were recorded for "Canter x Boyd" and "Boyd 1265," namely 1,318 lb. and 1,063 lb. per acre respectively, grown on sandy loam. A curing trial by the open fire method gave leaf of satisfactory dark to cherry red colour, but lacking in body and texture. For tobacco grown on a heavily manured soil, it is stated that this method of curing could be satisfactorily carried out in the Transvaal. There is, however, only a limited demand for this class of tobacco in South Africa, but when exported it would probably realise better prices than ordinary air-cured leaf.

In Western Cape Province, variety and manuring experiments with Turkish tobacco were carried out at thirty farms.

From the results obtained at the Barberton Experiment Station, "Sumatra (Sc)" and "Sumatra 1258" are recommended for the production of cigar-wrapper tobacco. Of the light air-curing varieties "Sterling" gave the best results, "Clardy" and "Yellow Prior" also proving satisfactory. "Macsvale" and "Clarksville N" gave the best results as heavy varieties for snuff. Two Levantine varieties, "Samsoum" and "Isketche," proved unsatisfactory at this station, yielding a coarse, dark tobacco.

For protecting seedlings, cheese cloth, placed about 6 in. above the soil, gave better results than long grass, chaff, or fresh stable manure spread over the surface, the young plants making better growth. With long grass and chaff, it was necessary to raise the covering immediately the seed had germinated, whilst manure produced an abundance of weeds. A detailed account of the cost of producing "Sumatra" and "Sterling" crops is given.

Drugs

Belladonna.—The *Ann. Rept. Kumaun* (India) *Govt. Gardens for the years* 1909–13 contain records of experiments in the cultivation of *Atropa Belladonna* from imported seed. The plants were grown at the Kutchery Garden, Naini Tal, and the yield per acre and alkaloidal content of the roots determined. Plants of one, two, and three years' growth

were examined in this way. The one-year-old plants yielded 3,570 lb. of roots per acre, containing 0·4 per cent. of alkaloid; the two-year-old plants yielded 3,545 lb. of roots per acre, containing 0·45 per cent. of alkaloid; whilst the three-year-old plants gave 2,900 lb. per acre of roots, with an alkaloidal content of 0·44 per cent. At Naini Tal the plants were found to be thoroughly established in the third year. As belladonna root imported from Europe contains from 0·2 to 0·6 per cent. of alkaloids, the samples examined are considered suitable for use in Indian medical store departments. The plant is easily grown, and is, so far, immune from insect attacks. It is believed that in better soil, such as is obtainable in the Ramgarh neighbourhood, heavier yields of root, richer in alkaloid, should be obtained. Further experiments are being made to determine whether the drug can be grown at a profit. For this purpose additional areas have been sown with seed from acclimatised plants.

FORESTRY AND FOREST PRODUCTS

The Protection of the Indigenous Flora and Fauna of Tropical Africa.—The measures taken by the countries concerned, for the protection of the indigenous flora and fauna of tropical Africa, form the basis of a paper prepared by Baron F. Fallon and read before the International Colonial Congress at Ghent in August 1913, a report of which is reprinted in *L'Agronomie Trop.* (1914, **6**, No. 1, pt. ii., p. 1). The author reviews in turn the efforts made in the various British, German, French, Portuguese, Italian, and Belgian colonies, for the protection and conservation of plant and animal life. In most British colonies great attention is paid to the regulation of felling, trees less than a certain diameter being saved. In some colonies the cutting of scarce species is prohibited, whilst in others Government forest reserves have been created. The regulations and measures against forest fires are rigorously enforced.

In all the British colonies regulations have been drawn up in accordance with the Convention for the Protection of the African Fauna, London, 1900, and these are strictly observed.

Forest Regulations of Madagascar.—The regulations, eighty-seven in number, drawn up by the French Government for the working of the Madagascar forests are enumerated in *L'Agronomie Colon.* (1913–14, **1**, Nos. 4 and 5, pp. 118, 152). They specify the conditions under which the forests may be exploited, and deal not only with the more important forest products, such as timber and fibres, but also govern the collection of such products as gums, resins, rubber, gutta, and bamboos.

Forestry in Korea.—The annexation of Korea by the Japanese in 1910 marked the institution, in the peninsula of Chosen, of a series of important administrative measures, not the least important being the proper control of the forests, which cover 73 per cent. of the total area of the peninsula.

Indiscriminate felling in the past has resulted in a scarcity of timber for building purposes and firewood, and the general deforestation has caused great injury to agriculture. The need for proper control of the forests had become so urgent that soon after the establishment of the Japanese protectorate, the late Korean Government commenced to encourage afforestation, and in 1907 began to establish model plantations and nurseries in different localities. Since 1910 this work has been extended and the report on forest work carried out in 1911–12, given in the *Annual Report on Reforms and Progress in Chosen (Korea) for* 1911–12, p. 175, records the inauguration of further improvements.

In July 1911, new forestry regulations were issued by the Governor-General. They aim not only at the continuance of the Government undertakings in afforestation, but also at stimulating the people themselves to undertake afforestation, and towards this end 4,820,000 seedlings and quantities of seed were distributed free during 1911. The investigation and survey of the forest boundaries have been commenced, while the botanical survey, though not yet completed, proves that about 300 species of trees exist in the peninsula.

The Beeches, Birches, and Maples of the United States.—The uses of the various species of *Fagus*, *Betula*, and *Acer* indigenous to the United States, where they are frequently known as "the hardwoods," are dealt with in *Bulletin* No. 12, 1913, *U.S. Dept. Agric.* The three genera, including eighteen commercial species, form a group of trees closely related in the technical properties of their timbers. They grow usually in the same regions and are frequently lumbered and milled as a single wood, though the resulting timber is piled and sold separately. The woods of all the species have several points of similarity, such as hardness, strength, and capability of fine polish, and, in the main, their uses are similar, the chief being for furniture, flooring and interior work, for agricultural implements and vehicles, musical instruments, and for domestic articles.

Prosopis juliflora.—Reference has been made previously in this BULLETIN (1913, **11**, 355), to the value of *P. juliflora* as a pioneer tree and sand-binder in the dry soils and arid districts of India. In the *Indian Forester* (1913, **39**, 320), a further account of its behaviour in the Punjab is given. Natural seedlings of this tree are said to be almost always

found on dry unirrigated land wherever large specimens occur, whilst seedlings of indigenous trees in such situations are usually absent. In resistance to drought *P. juliflora* has proved to be without an equal in the Punjab, and as it produces seeds in abundance it seems probable that it will become a common tree in all the drier districts in course of time. Its leaves are not readily eaten by cattle, and it appears to have no natural enemies in India, but a large proportion of the seed imported from America, where the tree is native, is said to be usually attacked by weevils.

Teak Cultivation in Java.—The teak forests of Java, which are estimated to occupy an area of from 600,000 to 650,000 hectares (1 hectare = 2·47 acres) are the property of the State. This increases year by year as a larger area is planted annually than is exploited. It is estimated that some 125,000 hectares have been planted during the last twenty-five years. The methods of culture adopted, as described in the *Journ. d'Agric. trop.* (1913, **13**, 353), are as follows: Soils of at least average richness are chosen for teak, as on poor or marshy land growth is very slow; wet soils can, however, be utilised if drained. A rainfall of at least 24 in. a year is essential, and an altitude not above 300 ft.

The trees are raised from seeds planted about 3 ft. apart, in lines 9 ft. apart, at the beginning of the rainy season. During the first year natives are allowed to cultivate rice and afterwards ground nuts between the lines. The growth is very rapid at first, and by the end of the first year the seedlings have become small trees. Little care is required to maintain the plantations beyond keeping out "alang-alang" (*Imperata arundinacea*), a grass which checks the growth of teak considerably. It has been found as a result of recent trials that the best method of checking the growth of alang-alang is to sow *Leucaena glauca* between the lines of teak. This is a leguminous plant, and is used in Java as a shade tree for coffee. Not only does it smother the grass, but it prevents the surface soil being washed away during heavy rains, and enriches the soil by adding humus and nitrogen. As soon as the teak trees have become large enough to form a canopy the Leucaena disappears. Teak forests formed in this way consist of trees with slender stems and few branches, standing very close together. Thinnings are necessary about every five years, and these afford sufficient wood to cover the cost of exploitation. For about three months during each year the teak trees lose their leaves, and as this occurs during the dry season there is then danger of fires; it is at this period also that the alang-alang makes advances, as there is then an absence of shade which is favourable to its growth.

The artificial teak forests of Java are at present young,

and it is not yet possible to say at what age the trees will attain a diameter of about 2 ft., which is the size fixed for exploitation; but in all probability this will be between eighty and a hundred years.

In the case of natural forests, which are the only ones at present exploited, the trees are ringed two years before being felled, and allowed to stand in order to acquire those qualities which give teak its value as timber. The ringing of the bark is done close to the soil, and also the cutting of the wood, to minimise loss of timber. The bulk of the teak produced in Java is used locally.

ECONOMIC MINERALS

Building Stones.—The Mines Branch of the Canadian Department of Mines has issued vol. i., by W. A. Parks, of a *Report on the Building and Ornamental Stones of Canada* (Ottawa: Government Printing Bureau, No. 100, 1912). This volume consists of two parts. Part I. is a general introduction to the subject, and deals with the chemical, physical, and geological features of building stones, together with the methods of quarrying, testing, and preparing stone for the market. Part II. gives a systematic description of the building and ornamental stones occurring in that part of Ontario lying south of the Ottawa and French rivers. It is the intention of the Department of Mines to issue a series of these volumes on the Building and Ornamental Stones of Canada. Each report is to deal with a certain section of the country, and the reports are to appear yearly, until practically all the stones now being quarried in the Dominion have been described. The first volume is richly illustrated.

Diamonds.—In the *Trans. Geol. Soc. South Africa* (1913, 16, 39), R. B. Young reports the discovery, by A. C. Lurie, of a diamond crystal in the black sands from the mortar boxes of the Modderfontein Branch Gold Mine. Diamond occurrences have been reported on previous occasions from the Rand banket. In this case the stone weighed about three-quarters of a carat, and was of a greenish colour. It had the form of the hexakis-octahedron with curved and slightly worn faces. All the stones hitherto obtained from the banket have been greenish in colour, and this is regarded as a proof that the occurrences are genuine. It is regarded as certain that the diamonds in the banket were deposited with the pebbles during sedimentation. The occurrence is of interest as proving that there exists a source of diamonds in the pre-Witwatersand rocks from which the banket was derived.

Gold.—The gold production of the Federated Malay States for 1913, as reported to the Secretary of State for the Colonies, is as follows:

	Oz. (troy).	Value at £3 17s. 6d. per oz.
Gold exported from the Federated Malay States	13,133	£50,891
Gold reported to have been bought by buyers in Perak. . .	1,842	7,138
Total	14,975	£58,029

This shows an increase of 554 oz. as compared with 1912, in which year the total production was 14,421 oz., valued at £55,881.

Iron Ore.—In *Economic Geology* (1914, **9**, 101) there is an article on the "itabirite" iron ores of Minas Geraes, Brazil, by E. C. Harder, a geologist who has had a considerable amount of experience among these deposits. Itabirite is the name given to a bedded siliceous iron-ore formation occurring in association with quartzites and schists. The itabirite formation varies in thickness from less than 15 metres to over 1,500 metres. Itabirite rarely contains less than 30 per cent. of metallic iron, and grades upwards through less siliceous material to richer ores containing not less than 50 per cent. of metallic iron. In addition to these massive deposits of more or less siliceous hæmatite, there is much ore (the so-called "canga") with a limonitic cement; this occurs at the surface, and has been formed by the action of weathering agencies on the itabirite. Soft powdery deposits of iron ore also occur, but though these have a high percentage of iron, they are considered undesirable because of their consistency. Occurring in the itabirite there are beds of hard massive iron ore of high grade, containing from 69 to 70 per cent. of metallic iron, and from 0·003 to 0·020 per cent. of phosphorus. This high-grade ore consists as a rule of finely specular hæmatite, but is occasionally of a coarse texture with an admixture of magnetite. It rarely contains more than 1 per cent. of silica, and its percentage of iron is remarkably constant. It occurs in lenses and beds varying up to more than a kilometre in length, and more than 150 metres in thickness. This is the only type of ore that is being considered at present in connection with the development of the Brazilian iron industry. As regards mode of origin, it is concluded that the itabirite deposits were formed as sedimentary rocks, and that they were subsequently altered, not by the action of weathering agencies, as some have supposed, but by deep-seated metamorphism. As evidence in support of the "sedimentary" view, it is mentioned that (1) the formation consists of a conformably bedded series; (2) the itabirite is interbedded with limestone; and (3) a difference is clearly discernible between beds that have been affected by weathering processes and those not so affected. This question of the origin of the itabirite ores is

one of considerable importance, since, if they were formed as sedimentary beds, they are likely to extend to a considerable depth; whereas, if they were formed by the concentrating effect of surface agencies, they are likely to be comparatively shallow in depth.

In *Bulletin* No. 64, 1913, *United States Bureau of Mines*, J. T. Singewald gives an account of the composition and economic value of the titaniferous iron ores in the United States. He deals with the results of an investigation into the economic possibilities of the larger deposits, and the applicability of processes of concentration in the utilisation of these ores. He gives a detailed account of the physical structure and chemical composition of the ores, and pays special attention to the possibility of utilising titaniferous iron ores at a profit with present methods and under existing conditions. The results of the investigation are chiefly negative, and on the whole disappointing. Some of the titaniferous iron-ore deposits are neither as large nor as good in quality as they were reported to be. It has been found that though a large part of the titanium in the ores is in the form of ilmenite, much of this is so intimately associated with the magnetite that separation by the magnetic method is, as a rule, impracticable. Only in a few cases are the ilmenitic portions of the ore sufficiently coarse to enable satisfactory results by magnetic separation to be obtained. In most cases, therefore, the problem presented is that of finding a suitable smelting process for the ore. In this direction the use of the electric furnace for the production of iron-titanium alloys seems to be the most promising line of development, as iron-masters are disinclined to adapt blast-furnace usage to the smelting of these titaniferous iron ores. The Bureau of Mines has undertaken further experiments on the possibility of adopting more efficient smelting methods, and promises to give the results of these experiments in future reports.

The Mines Branch of the Department of Mines, Canada, has published an account of the Austin-Brook iron-ore deposits, New Brunswick, by E. Lindeman (Ottawa: Government Printing Bureau, 1913, No. 105). These deposits are situated in Gloucester county, about 23 miles south-west of the town of Bathurst. The rocks of the district are chiefly foliated quartz-porphyry, associated with chlorite and sericite schists. The porphyry is traversed by gabbros and quartz veins, and appears to be intrusive in a slate formation which is probably of Ordovician age.

The ore bodies occur as elongated lenses in the quartz porphyry, and like the latter, are foliated. The ore is a fine-grained siliceous magnetite with a considerable amount of hæmatite, and it often shows bands of jasper. The metallic iron percentage of the ore varies from 35 to 59, the average

being about 45. The amount of sulphur is from 0·03 to 0·1 per cent. and phosphorus 0·8 per cent. Where the ore body is in contact with the country rock there are layers of iron pyrites, and ore taken from this position is liable to be high in sulphur.

The ore in its natural state is too siliceous to be marketable and requires to be concentrated. At the time of writing the report, a jigging process had been adopted, and a mill had been erected to treat 70 tons of crude ore per hour. A railway has been laid to the deposit, and an ore dock for transhipment has been built at Newcastle. The dock has a storage capacity of 13,000 tons, and a loading capacity of 3,000 tons per hour. The distance by railway from the mine to Newcastle is 57 miles. During 1910 and 1911 the shipments were 5,336 tons and 31,120 tons respectively.

Nickel Ore.—The Mines Branch of the Canadian Department of Mines has issued a well-illustrated monograph on "The Nickel Industry, with special reference to the Sudbury region, Ontario," by A. P. Coleman (Ottawa: Government Printing Bureau, 1913). The monograph includes a general geological map and special maps of the more important mines, and incorporates the advances made in a knowledge of the region due to work in the field extending over three summers. An account is given of the geology of the Sudbury region and of the mineral composition of the ores. All the known nickel ore deposits in Ontario are described in detail, and an account is given of the methods of mining and smelting the ores. The nickel deposits of other countries, including those of the United States, Cuba, Europe, New Caledonia, and Cape Province (Union of South Africa) are also dealt with.

Petroleum.—In a pamphlet dealing with the prospect of mineral oil being found in payable quantities in the Federated Malay States and other parts of the Malay Peninsula (Kuala Lumpur: F.M.S. Government Printing Office, 1913), J. B. Scrivenor gives a brief account of the conditions of occurrence of petroleum, and deals with the geology of the Malay Peninsula in relation to oil-occurrence. He infers that the conditions to be sought for in prospecting for oil are as follows:

1. Porous rocks capable of holding oil.
2. Beds rich in fossils, especially plant remains, that might form oil.
3. A structural arrangement of the rocks, such as an anticline, that favours storage of oil under pressure in porous rock underneath an impervious rock.
4. A porous rock outcropping on the surface through which oil is being floated upwards by rising water, giving surface evidence of oil.

In answering the question whether these conditions obtain in the Malay Peninsula, he states that the greater part of the country is composed of rocks, older than the Mesozoic granite, which have lost whatever porosity they once possessed, and are therefore incapable of holding oil. Of the deposits younger than the Mesozoic granite, the coast deposits are, he believes, too young to furnish any large quantity of oil. This leaves only the Tertiary rocks, of which only two outcrops are known, and it is to these that the attention of the prospector is directed. He concludes that, on the whole, the prospects of finding payable quantities of oil in the Peninsula are not encouraging.

NOTICES OF RECENT LITERATURE

THROUGH JUBALAND TO THE LORIAN SWAMP. By I. N. Dracopoli, F.R.G.S., with 44 illustrations and 2 maps. Pp. 318, Demy 8vo. (London: Seeley, Service & Co., 1914.) Price 16*s.* net; post free, United Kingdom 16*s.* 5*d.*, abroad 16*s.* 9*d.*

In the vast unexplored and uninviting lands between the Tana and the Juba Rivers, in British East Africa, Mr. Dracopoli has carried out, with conspicuous success, a journey of exploration between Kismayu, on the coast, and the Lorian Swamp, and has brought back an excellent map from plane table and prismatic compass traverses along his line of route. Special attention was given to the geography, the natives, and the natural history of Jubaland. In the handsome volume which records the results of this journey of exploration a very full account of southern Jubaland and of the obstacles that were successfully overcome in penetrating this difficult, and in many parts previously unknown, country is given. The hydrography of the inland drainage area, between the Juba and Tana Rivers, is very complex; there are no permanent streams and but few water-holes. Mr. Dracopoli's journey was an essential step to settlement in the country. His investigation of the Uaso Nyiro, connecting with the Lorian Swamp, and of the unknown country to the east, as far as Afmadu, is a valuable contribution to geography.

THE SETTLER AND SOUTH AFRICA. By William Macdonald, D.Sc. Pp. 159, Pott 4to. (London: Union-Castle Line, 1913.) Price 6*d.*; post free United Kingdom and abroad 9*d.*

This excellent little book is to be warmly recommended to those proposing to farm in South Africa—a term which may be held to include Swaziland and Rhodesia. People in this country who regard "South Africa" as synonymous with mineral wealth, and little else, would do well to consider the numerous and varied agricultural industries

described by Dr. Macdonald, and to reflect upon the potentialities involved. In the opinion of the author the Land Settlement Act of 1912 is destined to have a profound influence upon the future of South Africa. Under this Act, the Minister of Lands possesses wide powers over funds voted by the Union Parliament for "closer settlement," upon which the agricultural development of the country in great measure depends. The conditions imposed for a Government holding are not onerous, but they assume a certain amount of capital in the possession of the farmer, for South Africa is not the country for a settler virtually destitute of means. The needs of the farmer are now well served by the Government, which, in addition to the Land Settlement Act already referred to, supports a highly organised Department of Agriculture and a Land Bank. On these matters and on those relating to the crops and industries themselves—maize, fruit, wattle, tea, wine, wool, livestock, dairying, and ostrich farming, to mention the more important—the intending settler will find concise, scientific information that should be of great value to him in directing his energies upon right lines. The book is well printed, admirably illustrated, and issued at a negligible price.

BEYOND THE PIR PANJAB. Life and Missionary Enterprise in Kashmir. By Ernest F. Neve, M.D., F.R.C.S. (Edin.) Pp. viii + 178, Demy 8vo. (London: Church Missionary Society, 1914.) Price 2*s.* 6*d.*; post free, United Kingdom 2*s.* 10*d.*, abroad 3*s.*

Dr. Neve gives in this book a very interesting account, based on an experience covering a quarter of a century, of the beautiful vale of Kashmir and its primitive inhabitants, together with a record of missionary enterprise, educational and hospital work. He also has something to say on Kashmiri Tibet, and provides a valuable chapter on the Upper Indus Valley; he concludes with a general survey of Kashmir as a sphere for medical mission work, the extent and value of which have an important bearing on the development of the country. The illustrations are excellent.

A VIEW OF THE ART OF COLONIZATION, in letters between a Statesman and a Colonist. By Edward Gibbon Wakefield. With an introduction by James Collier. Pp. xxiv + 510, Extra Crown 8vo. (Oxford: Clarendon Press, 1914.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 8*d.*

A reprint of Wakefield's famous treatise on the whole *Art of Colonization* (1849), with an introduction by Mr. James Collier, should go far to stimulate an interest in the fundamental problems of national colonisation and Imperial development, which too often are made subservient to the immediate practical needs of migration and commercial

exploitation. Wakefield in his day, as is well known, was a leading Colonial Reformer and a thorn in the side of constituted authority: his fiery crusade against "Mr. Mother-country" rule kept him in constant conflict. Thrown into the form of an interchange of letters between "the Colonist" —Wakefield himself—and "the Statesman," whose identity is still unknown, the views of the author are set forth with a freshness and verve that compensate for their imperfect manner of presentation. His principal and successful reform—the sale of waste lands in the Colonies at a "sufficient price"—is dealt with in elaborate detail; otherwise his views in this volume are somewhat fragmentary and inconclusive, and some of course are inapplicable at the present day. But the principles and theories that underlie and support his system of colonisation remain of fundamental value.

CANADIAN ADDRESSES. By the Hon. George E. Foster. Edited by Arnold Winterbotham. Pp. xxi + 324, Crown 8vo. (London: Herbert Jenkins, Ltd., 1914.) Price 5*s.* net.; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 5*d.*

In these addresses the views of a Canadian statesman (Minister of Trade and Commerce) on leading problems of the British Empire are set forth with eloquence and insight, and with a breadth of treatment that arrests and holds the attention of the reader. Mr. Foster has the uncommon gifts of being able to appreciate, and to state with fairness and precision, not only the splendid heritage and opportunities of the Dominions but also their prime indebtedness to the Mother country and their obligations as integral parts of a united Empire. This relationship has seldom been discussed with greater skill and individual detachment: and the author's tribute to the responsibilities and claims of the parent State will recommend Mr. Foster's Addresses to a wide audience. "Our greatest enemies," says Mr. Foster in his introduction, "are drift and *laissez faire*. Let us enthrone organisation—Empire organisation and development; broad-based and effective. Let us rekindle the ancient fires of patriotic service, reincarnate the ancient virtues of courage and sacrifice, and begin at once the great crusade for the regeneration and firm establishment of an Imperial Britain." Autonomist as regards the Dominions, he is frankly an Imperialist in his outlook on the Empire.

MAIZE: its History, Cultivation, Handling and Uses; with special reference to South Africa. By Joseph Burtt-Davy, F.L.S., F.R.G.S. Pp. xl + 831, Med. 8vo. (London: Longmans, Green & Co., 1914.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 26*s.* 4*d.*

The author is to be congratulated on this comprehensive work, which must for long stand *facile princeps* in the ex-

tensive literature of maize. The remarkable position of maize as a feeding-stuff, and the part it plays in the world's agriculture, are scarcely realised in this country. Maize is stated to be produced in greater quantity than any other cereal, the world's annual crop reaching nearly 4,000 million bushels, three-quarters of which are raised in the United States. In 1899, the American crop exceeded in value by £5,000,000 all the products of the iron and steel industries of that country, and surpassed the combined value of the wheat and cotton crops. The secondary position of maize in European markets is no doubt in part due to the fact that, in spite of the enormous American production, the grain is not grown in the United States for export purposes: no less than 98 per cent. of the total crop is retained in the country, and the major part converted into beef or pork before it leaves the farm on which it was grown.

An attractive feature of maize-growing is the stability of the demand for the product, and this fact has a powerful influence in inducing agriculturists in "new" countries to rely, in varying measure, upon the crop. In this connection reference may be made to the development of the maize industry in South Africa, in which the part played by the author, as Government Agrostologist and Botanist, is well known. Maize has become the staple cash crop of the South African farmer, and Mr. Burtt-Davy regards the country as unrivalled, in natural conditions, as a maize-growing area, stating that the climatic circumstances of a large part of the Orange Free State, the Transvaal, Natal, Rhodesia, Basutoland, Swaziland, and the Transkei, are all that could be desired for the crop.

The economic and agricultural conditions under which the American farmer raises his crop should be borne in mind by maize-growers in all parts of the world. In the corn belt of the United States, maize is raised entirely by white labour earning £5 a month and board, yet the crop pays because it can be handled almost entirely by machinery; because the soil is in good condition and the crop well cultivated; and because the farmer realises the value of good seed: moreover, the great bulk of the crop is raised on small or moderate-sized farms of from 80 to 300 acres.

Space does not permit of adequate reference to the large amount of information brought together in this volume. Among the most important sections are those dealing with the improvement of the crop by selection and breeding, and the cognate subjects of "varieties and breeds," and "judging and selection." The chapter on the "inheritance of characters and improvement by breeding" is admirable, and of especial significance for South African farmers. It is pointed out that if South Africa is in fact to become the "maize granary of Europe," a greater

production is a necessity, since, unless the present output is increased, there is some risk of a loss of the market she has already gained for lack of a constant, dependable supply. A larger production may be secured by an extension of the area under the crop, a more intensive cultivation, and the increase of the yield per acre by scientific plant-breeding. There would appear to be ample room for improvement in the South African yield, which is reported to average no more than 4 to 5 muids (14¼ to 18 bushels) per acre; but it has now been shown that, without undue expense, yields of 10 to 12 muids (35½ to 42½ bushels) can be obtained over hundreds of acres. The chapters on the culture of the crop and the related matters of diseases, harvesting, and storage, are thoroughly practical, and, while primarily concerned with South African experience, should be of the greatest service to all maize-farmers. The crop is dealt with entirely from the modern standpoint, full reference being made to the employment of labour-saving machinery, several types of which are illustrated. Much important information is contained in the chapter on "Commerce in Maize Grain," in which will be found an account of the Government system of grading and an explanatory list of the now well-known standard "classes" of South African maize. Samples of these grades are furnished regularly to trade organisations in this country, and a series is exhibited in the South African Court at the Imperial Institute.

Reference must be made to the numerous and excellent illustrations and to the exhaustive bibliography, while the complete index is a valuable feature. In the chapter on "botanical characters" an error has been overlooked in quoting the castor-oil bean as an example of an "ex-albuminous" seed.

Coconut Cultivation and Plantation Machinery. By H. L. Coghlan and J. W. Hinchley, A.R.S.M., Wh.Sc., F.C.S. Pp. x + 128, Small Crown 8vo. (London: Crosby, Lockwood & Son, 1914.) Price 3*s.* 6*d.*; post free United Kingdom and abroad 3*s.* 9*d.*

This small book covers a wide field and includes a large amount of useful information on the establishment and management of coconut plantations in Malaya; the pests and diseases of the coconut; the preparation of copra, oil, and coir fibre, and the machinery used. It also deals with other subjects closely allied to the coconut industry, such as the cultivation of Robusta coffee as a catch crop. The coconut industry of the West Indies is briefly dealt with in the concluding section.

The information is in a very condensed form, but appears to be accurate. The book is free from errors or misprints, but the description of rough methods of soil

analysis in less than two pages might be omitted with advantage; soil analysis is best left to trained chemists, and results of real value could not be obtained by the rough methods described.

ALL ABOUT COCONUTS. By R. Belfort and A. J. Hoyer. Pp. xii + 201, Demy 8vo. (London: St. Catherine Press, 1914.) Price 6*s.* net; post free, United Kingdom 6*s.* 4*d.*, abroad 6*s.* 7*d.*

This book is written in a popular style, and has obviously been compiled chiefly for the purpose of affording the reader an idea of the financial and industrial possibilities of coconut planting in different countries. The information given is generally correct, though it is sometimes conveyed in language that is perhaps unduly eulogistic. For the actual planter's use detailed references to the original sources of information would have added greatly to the value of the book. References of this kind are particularly needed in such cases as those on pages 134 and 135, where different processes for the sterilisation of copra are referred to, but where no details are given.

The sections dealing with the coconut planting industry are among the best in the book, but those dealing with the preparation and utilisation of coconut-palm products, such as coir, copra, and oil, are distinctly poor. The authors should have enlisted the services of a qualified technologist to assist with this important part of their book. The book contains numerous illustrations, most of which are excellent.

THE CULTIVATION OF THE OIL PALM. By F. M. Milligan, F.R.G.S. Pp. xii + 100, Small 8vo. (London: Crosby, Lockwood & Son, 1914.) Price 2*s.* 6*d.* net; post free United Kingdom and abroad 2*s.* 9*d.*

The cultivation of the oil palm is a subject of increasing importance, about which comparatively little is known owing to the fact that so far natural regeneration of the tree has been relied on almost entirely. In these circumstances it is by no means easy to give trustworthy and complete advice on all the questions which arise in the formation of an oil-palm plantation, and this little book reflects this difficulty. It is written in a discursive style, and the information is often too vague and general to be of real value, and is sometimes misleading. A notable omission is the absence of any reference to the existence of varieties of the oil-palm, some of which are preferable to others for planting purposes if they can be grown true to seed. Nevertheless, the book contains some sound advice, and if the author would drastically revise what may perhaps be called the scientific portions of the book, and add a chapter on oil-palm machinery, it could be made into a useful treatise on the subject, and a book of this kind in English would be very valuable at the present time.

DER BAUMWOLLBAU IN DEN DEUTSCHEN SCHUTZGEBIETEN: SEINE ENTWICKLUNG SEIT DEM JAHRE 1910. Pp. ix + 295, Med. 8vo. (Jena: G. Fischer, 1914.)

In 1910, the German Colonial Office issued a work entitled *Die Baumwollfrage* (cf. this BULLETIN, 1911, **9**, 190), which drew attention to the deficiency in the world's production of cotton and the causes thereof, and indicated the measures which were being taken by different countries to increase the supply. In the same year an arrangement was concluded between the Secretary of State for the German Colonies and the Colonial Economic Committee, in accordance with which the Government undertook to co-operate in the work of advancing cotton growing in the Colonies. Since that time much earnest and laborious work has been done, a record of which has now been published by the German Colonial Office in the volume under notice. Separate chapters are devoted to German East Africa, Kamerun, and Togo, and in each a detailed account is given of the natural conditions of the country, the measures which have been taken to develop cotton growing, and the results so far achieved. The work is well illustrated with photographs and plans of the various experiment stations, and constitutes a valuable memoir of German activity in the direction of cotton cultivation.

A TEXTBOOK OF MEDICAL ENTOMOLOGY. By W. S. Patton, M.B., I.M.S., and F. W. Cragg, M.D., I.M.S. Pp. xxxiii + 764, Small 4to. (London, Madras, and Calcutta: Christian Literature Society for India, 1913.) Price 21*s.*; post free United Kingdom 21*s.* 7*d.*

The need for a comprehensive book dealing with entomology in relation to disease has been long felt by medical officers in the tropics. Until recently, when journals specially devoted to this subject were founded, the results of investigations were recorded in many publications, and the authors of the present work have performed a most useful service in gathering together this scattered information and making it available to those workers who are out of reach of extensive libraries.

After a detailed account of the anatomy and physiology of the blood-sucking flies, the different families of Diptera are dealt with, special attention being paid to those insects which occur in tropical regions. The bionomics of the insects are considered in detail, and descriptions of the various genera and species of mosquitoes, house-flies, midges, etc., are provided. Subsequent chapters deal in a similar way with fleas, bugs, lice, ticks, mites, tongue-worms, and water-fleas. A most valuable feature is the description of the various methods of breeding blood-sucking insects in the laboratory for the purpose of investigating their relation to disease. A chapter is devoted

to the preparation and microscopical examination of insect tissues, and the book concludes with a general discussion of the relations between blood-sucking insects and disease.

There are eighty-nine plates of line and half-tone drawings, illustrating the structure of the insects dealt with, and references are given to the more important literature dealing with the various groups.

THE DIAMOND FIELDS OF SOUTHERN AFRICA. By P. A. Wagner. Pp. xxv + 347, Small 4to. (Johannesburg: *The Transvaal Leader*, 1914.) Price *27s. 6d.* net; post free, United Kingdom *28s.*, abroad *28s. 9d.*

This book is a revised and greatly enlarged English edition of Dr. Wagner's *Die Diamantführenden Gesteine Südafrikas, Ihr Abbau und Ihre Aufbereitung*, which was published in 1909. Since that time the author has pursued his studies among the South African diamond fields, with good opportunities for making further observations and collecting. How well he has used those opportunities this book testifies.

It is divided into three parts. Part I. deals with "The Primary Occurrences," and includes an account of the geology, petrography, and mineralogy of the rock (kimberlite) in which the diamonds occur. This part also includes a discussion of the origin of the diamond, a description of the methods of mining and concentration, and an account of the economics of diamond mining. Part II. describes the alluvial deposits of the Vaal River basin, the Orange River valley, and German South-West Africa. Part III. gives an account of the diamond-mining companies in various parts of South Africa, and deals with statistics of production, etc.

The treatment of the subject is well-balanced and thoroughly up-to-date, incorporating, as it does, even the most recent work. The author himself has contributed several notable scientific papers on the subject, and has made a close study of the work done by others, as is shown not only in the comprehensive bibliography which he has given to the reader, but also in the concise way in which he has stated the views of the various authorities to whose work he refers.

One unpardonable error committed by the author is the absence of an index. An attempt has been made to compensate for this by giving a fairly full list of contents, but a good index is indispensable for reference in a book of this character, and it is to be hoped that in future editions this defect will be remedied.

The illustrations are numerous and good; they include several maps, one of the diamond fields of Griqualand West, and another showing the principal occurrences of kimberlite and alluvial diamond-bearing deposits of South Africa.

The book is clearly written, well printed, and only a few misprints have been noticed. It is readable as well as scientific, and can be recommended to any one who wishes to have a complete and trustworthy account of the South African diamond deposits and their exploitation.

LA SILICE ET LES SILICATES. By H. Le Chatelier. Pp. 574, Roy. 8vo. (Paris: A. Hermann et Fils, 1914.) Price 15 francs; post free, United Kingdom 12*s.* 7*d.*, abroad 13*s.* 5*d.*

In this treatise the author has dealt with silica and silicates chiefly from a scientific, and to some extent also from a technical, point of view. The matters dealt with include a description of the different varieties of silica, the optical and other physical properties of quartz, transformations of silica at different temperatures, the properties and different varieties of glass and other silicates, ceramics, rocks, and slags.

It is scarcely wise to expect from one author that he should be able to deal adequately with all these subjects. The task is one calling for the co-operation of many specialists rather than the efforts of one worker. M. Chatelier has brought together a large amount of information, but it is to the general reader rather than to the specialist that his book will appeal.

Very little is said about the chemical constitution and analysis of silica and the silicates, and the mineralogical treatment of the subject is not only incomplete, but contains many misleading statements. Thus on p. 414 the reader is informed with reference to wollastonite that "C'est un élément constitutif des syénites à néphéline."

Again on p. 456 the term "kaolinite" is used as if it should be applied to a substance having the chemical composition represented by the formula $Al_2O_3 2SiO_2 2H_2O$, irrespective of the physical condition of the substance.

Some twenty pages devoted to rocks deal only with the origin and classification of rocks, and an account is given of the quantitative system of classification. With reference to classification it is scarcely correct to say, as M. Chatelier does, that "On divise généralement les terrains en quatre grands groups: les roches sédimentaires, les roches volcaniques, les roches filoniennes, les roches primitives cristallisées" (p. 517). Moreover, if one is to deal with rocks in a publication such as this, it would be better to give some simple and illustrated account of their nature and texture, and show how they differ from one another.

The inadequacy that characterises M. Chatelier's scientific treatment characterises also his treatment of the technical aspects of silica and the silicates. Glass is dealt with at some length, but any one requiring information on silica and the silicates in relation to the cement, ceramic,

and metallurgical industries is not likely to find the book of much use. Moreover, only the properties of the various substances concerned are dealt with at any length, no attempt being made to describe actual processes of manufacture.

The illustrations are few, and there are some fairly obvious misprints. The book is of some value as a readable compilation giving a large amount of information, and showing how important silica and the silicates are to workers in various sciences and industries; but its value as a work of reference is seriously diminished by the absence of an index.

THE MINING WORLD INDEX OF CURRENT LITERATURE. Vol. IV., second half-year, 1913. By G. E. Sisley. Pp. xxviii + 190, Med. 8vo. (Chicago: The Mining World Company, 1914.) Price $1.50; post free, United Kingdom 6*s.* 7*d.*, abroad 6*s.* 10*d.*

This is the fourth volume of the Mining World Index of Current Literature. Like previous volumes, it attempts to cover the world's literature on mining, metallurgy, and kindred subjects. It claims to classify "all articles appearing in periodical magazines published in America, Europe, Africa, and Australia on mining, mining engineering, metallurgy, mining geology, mineralogy, etc.; also the valuable publications of the world's mineral industries, institutes, and affiliated engineering and technical societies, as well as publications of the federal and state geological surveys and mining bureaus at home and abroad." On looking through its list of publications indexed, however, one misses some that might well be included. Of these the *Mineralogical Magazine* and the *Journal of the Institute of Metals*, both of London, should be mentioned; also the publications issued by the Government Geologist of the Federated Malay States, and the *Bulletins* of the Geological Survey of Southern Rhodesia.

One needs only to glance through the pages of this index to see how very useful it is, and every step in the direction of greater completeness will be welcomed by those who use it.

BOOKS RECEIVED

THE OXFORD SURVEY OF THE BRITISH EMPIRE. Edited by A. J. Herbertson, M.A., Ph.D., and O. J. R. Howarth, M.A. 6 vols. Vol. I.: The British Isles and Mediterranean Possessions. Pp. xii + 596. Vol. II.: Asia. Pp. x + 505. Vol. III.: Africa. Pp. xvi + 547. Vol. IV.: America. Pp. x + 511. Vol. V.: Australasia. Pp. xii + 584. Vol. VI.: General Survey. Pp. viii + 386. (Oxford: Clarendon Press.) Price, £3 10*s.* net; or, separately, 14*s.* net per volume.

THE WILDS OF MAORILAND. By J. M. Bell, M.A., Ph.D. Pp. xiii + 257. (London: Macmillan & Co., Ltd.) Price 15s.

NEW ZEALAND: Its History, Commerce and Industrial Resources. Compiled by Somerset Playne, F.R.G.S., assisted by J. W. Bond and H. H. F. Stockley, F.R.G.S. Edited by F. Holderness Gale. Pp. 699. (London: The Foreign and Colonial Compiling and Publishing Co.) Price 25s. net.

LA GÉOGRAPHIE DE TERRE-NEUVE. By Robert Perret. Pp. vi + 372. (Paris: E. Guilmoto.) Price 10 francs.

INDUSTRIAL AND COMMERCIAL GEOGRAPHY. By J. Russell Smith. Pp. xi + 914. (London: Constable & Co., Ltd.; New York: Henry Holt & Co.) Price 15s. net.

CULTURE ET EXPLOITATION DU CAOUTCHOUC AU BRÉSIL. By O. Labroy and V. Cayla. Pp. 235. (Paris: Société Générale d'Impression.)

DATE GROWING IN THE OLD WORLD AND THE NEW. By Paul B. Popenoe. Pp. 316. (Altadena, California: West India Gardens.) Price $2 net.

THE TIMBERS OF BRITISH GUIANA: A Report upon the Collection made by the Hon. A. G. Bell, M.Inst.C.E. By Herbert Stone and W. G. Freeman. Pp. xi. + 110. (London: The Crown Agents for the Colonies.) Price 5s. net.

DIE WICHTIGSTEN KRANKHEITEN UND SCHÄDLINGE DER TROPISCHEN KULTURPFLANZEN UND IHRE BEKÄMPFUNG. By Fr. Zacher. Band I. Pp. viii + 152. (Hamburg: Fr. W. Thaden.) Price 4 marks.

IGNEOUS ROCKS AND THEIR ORIGIN. By R. A. Daly. Pp. xxii + 563. (London: Hill Publishing Co.) Price 17s. net.

MANUAL OF PETROGRAPHIC METHODS. By A. Johannsen, Ph.D. Pp. xxviii + 649. (London: Hill Publishing Co.) Price 25s. net.

DAS AUFSUCHEN UND DIE UNTERSUCHUNG VON LAGERSTÄTTEN NUTZBARER MINERALIEN IN DEN TROPEN. By O. Mann. Pp. iv + 92. (Hamburg: Fr. W. Thaden.) Price 2.80 marks.

THE FIXATION OF ATMOSPHERIC NITROGEN. By J. Knox, D.Sc. Pp. vii + 112. (London: Gurney & Jackson.) Price 2s. net.

THE AMERICAN FERTILIZER HANDBOOK, 1914. Pp. 470. (Philadelphia: Ware Bros.) Price $1.

DIRECTORY OF PAPER MAKERS OF THE UNITED KINGDOM for 1914. Pp. 235. (London: Marchant Singer & Co.) Price 1s. net.